Assessing the Potential Effects of Climate Change on National Forests and Grasslands in Texas

Forestlands across the region are experiencing increased threats from fire, insect and plant invasions, disease, extreme weather, and drought. Scientists project increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity, and/or for longer durations. Although many of the effects of future changes are negative, natural resource management strategies can help mitigate these impacts. Responses informed by the best current science enable natural resource professionals within the Forest Service to better protect the land, resources, and the region's forestlands into the future.

Forest and Grassland Health - Invasive and aggressive plant and insect species may increasingly outcompete or negatively affect native species in the future. Winter freezes historically limit the range of forest pests but higher temperature will likely allow increases in their number and spread. Drought and other factors will increase the susceptibility of forests to destructive insects such as southern pine beetle. Certain invasive plant species, found in these grasslands, including Chinese tallow trees, are expected to increase dramatically as they can tolerate a wide range of harsh conditions, allowing them to rapidly move into new areas.

Response: Manage tree densities through practices such as thinning and prescribed fire to maximize carbon sequestration and reduce the vulnerability of forest stands to water stress, insect and disease outbreaks, and wildfire.

Response: Continually monitor for new invasive species moving into areas where they were not traditionally found, especially following events such as hurricanes and fire.

Southern pine beetle

Plant Communities - Heat stress may limit the growth of some southern pine and hardwood species. Stress from drought and wide-scale pest outbreaks have the potential to cause large areas of forest dieback. Intensified extreme weather events, such as hurricanes and fire, are also expected to cause changes in plant community composition. Species of some rare or endemic plants may be disproportionately impacted. Species more resistant to these disturbances will be more resilient to a changing climate.

Response: Manage for a range of ages and species in forests to lessen potential loss from drought or infestation.

Longleaf pine

Animal Communities - Wildlife species will be affected in different ways. Amphibians may be most at risk, as suitable habitat decreases due to warmer, dryer conditions. Migrating bird species that depend on the Gulf of Mexico may find previous pathways have shifted with sea level rise and temperature increases. Alternatively, deer populations may increase in number due to higher survival rates during warmer winters.

Response: Maintain piles of natural woody debris in areas of high amphibian diversity to supplement habitats that retain cool, moist conditions.

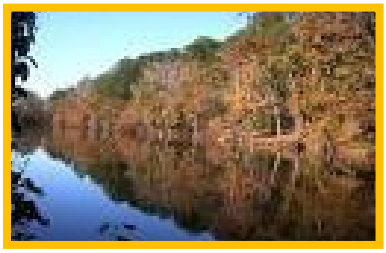
Response: Create habitat corridors, assist in species movement, and identify high-value conservation lands adjacent to National Forests.

Response: Identify and maintain crucial bird migration corridors for protection as well as wildlife viewing in the forest.

Red-Cockaded Woodpecker

Coastal Ecosystems - Coastal areas in the Southeast have already experienced an average of one inch of sea level rise per decade over the 20th century, a rate that will continue to increase in the future. Rising sea levels, in combination with more intense hurricanes, will alter the composition of coastal marshes. As saltwater flooding expands, low-lying coastal forests and wetlands could become marshland or turn into ghost forests where land use barriers do not exist. Sea level rise can also increase the potential for saltwater intrusion into coastal freshwater tables. Increasing salinity of coastal aquifers may affect groundwater resources within three miles of the coast.

Response: Identify and preserve landward migration corridors next to coastal wetlands that can allow these ecosystems to shift landward as sea levels rise.



Angelina National Forest

Extreme Weather - The potential for severe storm events is expected to increase in the future, including more intense hurricanes making landfall in the southern US. Extended periods of extreme high temperature and drought may lead to drier forest fuels which will burn more easily and contribute to larger and more frequent wildfires. More cloud-to-ground lightning due to warming may also increase wildfire ignitions.

Response: Identify areas that provide particularly valuable ecosystem services, like timber harvest or carbon sequestration, and are also vulnerable to extreme weather, like hurricanes or fires. Then plan conservation strategies (e.g. thinning, prescribed burns, species selection) accordingly to mitigate for extreme weather impacts.

Response: Reduce increased wildfire potential by conducting prescribed burns.

Fishing

Water Resources - Shifts in rainfall patterns will lead to periods of flooding and drought that can significantly impact water resources. Increases in heavy downpours and more intense hurricanes can lead to greater erosion and more sedimentation in waterways. Increased periods of drought may lead to poor water quality. Geographically isolated wetlands are critical wildlife habitat and can be impacted by changes in surrounding landcover.

Response: Reduce the amount of water taken in by surrounding trees and plants, with management practices such as thinning and prescribed burns, in order relieve stress on isolated wetlands and streams.

Response: Restore and reinforce vegetation in headwater and marsh areas to help alleviate runoff of sediment during heavy rain, reduce climate-induced warming of water, and decrease water sensitivity to changes in air temperature.

Wildfire

Recreation - Environmental changes may negatively impact recreational experiences due to changes in the plant and animal communities that make those experiences unique. More days above freezing could increase tick and mosquito populations throughout the year, leading to an increase in vector-borne illness With more days of extreme heat, recreation areas could see decreased use in the summer if temperatures impact visitor comfort.

Response: Communicate early warnings for extreme weather to protect vulnerable groups from health impacts, such as heat illnesses, and monitor for early outbreaks of disease.

Climate Change and Your National Forest: Citations

Information in this factsheet is summarized from 47 peer-reviewed science papers found in the USDA Forest Service's TACCIMO tool. TACCIMO (the Template for Assessing Climate Change Impacts and Management Options) is a web-based application integrating climate change science with management and planning options through search and reporting tools that connect land managers with peer-reviewed information they can trust. For more information and the latest science about managing healthy forests for the future visit the TACCIMO tool online: **www.forestthreats.org/taccimotool**

Forest Health

Duehl, A. J., Koch, F. H., & Hain, F. P. (2011). Southern pine beetle regional outbreaks modeled on landscape, climate and infestation history. Forest Ecology and Management, 261(3), 473-479. doi:10.1016/j.foreco.2010.10.032

Formby, J. P., Rodgers, J. C., Koch, F. H., Krishnan, N., Duerr, D. A., & Riggins, J. J. (2018). Cold tolerance and invasive potential of the redbay ambrosia beetle (Xyleborus glabratus) in the eastern United States. Biological invasions, 20(4), 995-1007

Greenberg, C. H., Perry, R. W., Franzreb, K. E., Loeb, S. C., Saenz, D., Rudolph, D. C., ... & Tanner, G. W. (2013). Climate Change and Wildlife in the Southern United States. In: Vose, J. M., Klepzig, K. D., eds. Climate change adaptation and mitigation management options: A guide for natural resource managers in southern forest ecosystems. Boca Raton, FL: CRC Press. 379-420

Guldin, J. M. (2019). Silvicultural options in forests of the southern United States under changing climatic conditions. New forests, 50(1), 71-87.

Iverson, L. R., Prasad, A. M., Peters, M. P., & Matthews, S. N. (2019). Facilitating Adaptive Forest Management under Climate Change: A Spatially Specific Synthesis of 125 Species for Habitat Changes and Assisted Migration over the Eastern United States. Forests, 10(11), 989.

Just, M. G., & Frank, S. D. (2020). Thermal Tolerance of Gloomy Scale (Hemiptera: Diaspididae) in the Eastern United States. Environmental Entomology.

Kolb, T. E., Fettig, C. J., Ayres, M. P., Bentz, B. J., Hicke, J. A., Stewart, J.E. & Weed, A. S. (2016). Observed and anticipated impacts of drought on forest insects and diseases in the United States. Forest Ecology and Management, 380, 321 – 344. http://dx.doi.org/10.1016/j.foreco.2016.04.051

Mech, A. M., Tobin, P. C., Teskey, R. O., Rhea, J. R., & Gandhi, K. J. (2018). Increases in summer temperatures decrease the survival of an invasive forest insect. Biological invasions, 20(2), 365-374.

Osland, M. J., & Feher, L. C. (2019). Winter climate change and the poleward range expansion of a tropical invasive tree (Brazilian pepper-Shinus terebinthifolius). Global change biology.

Seidl, R., Thom, D., Kautz, M., Martin-Benito, D., Peltoniemi, M., Vacchiano, G., Wild, J., Ascoli, D., Petr, M., Honkaniemi, J. & Lexer, M. J. (2017). Forest disturbances under climate change. Nature climate change, 7(6), 395.

Plant Communities

Clark, J. S., Iverson, L., Woodall, C. W., Allen, C. D., Bell, D. M., … & Zimmermann, N. E. (2016). The impacts of increasing drought on forest dynamics, structure, and biodiversity in the United States. Global Change Biology, 22, 2329 – 2352. doi: 10.1111/gcb.13160

Clark, K. E., Chin, E., Peterson, M. N., Lackstrom, K., Dow, K., Foster, M., & Cubbage, F. (2018). Evaluating climate change planning for longleaf pine ecosystems in the Southeast United States. Journal of the Southeast Association of Fish and Wildlife Agencies, 5, 160-168.

Conrad, A. O., Crocker, E. V., Li, X., Thomas, W. R., Ochuodho, T. O., Holmes, T. P., & Nelson, C. D. (2020). Threats to Oaks in the Eastern United States: Perceptions and Expectations of Experts. Journal of Forestry, 118(1), 14-27.

Guldin, J. M. (2019). Silvicultural options in forests of the southern United States under changing climatic conditions. New forests, 50(1), 71-87.

Potter, K. M., Crane, B. S., & Hargrove, W. W. (2017). A United States national prioritization framework for tree species vulnerability to climate change. New forests, 48(2), 275-300.

Rogers, B. M., Jantz, P., & Goetz, S. J. (2017). Vulnerability of eastern US tree species to climate change. Global change biology, 23(8), 3302-3320.

Schwantes, A. M., Swenson, J. J., González-Roglich, M., Johnson, D. M., Domec, J. C., & Jackson, R. B. (2017). Measuring canopy loss and climatic thresholds from an extreme drought along a fivefold precipitation gradient across Texas. Global change biology, 23(12), 5120-5135.

Stambaugh, M. C., Guyette, R. P., Stroh, E. D., Struckhoff, M. A., & Whittier, J. B. (2018). Future southcentral US wildfire probability due to climate change. Climatic change, 147(3-4), 617-631.

Stroh, E. D., Struckhoff, M. A., Stambaugh, M. C., & Guyette, R. P. (2018). Fire and Climate Suitability for Woody Vegetation Communities in the South Central United States. Fire Ecology, 14(1), 106-124

Trenberth, K. E., Cheng, L., Jacobs, P., Zhang, Y., & Fasullo, J. (2018). Hurricane Harvey links to ocean heat content and climate change adaptation. Earth's Future, 6(5), 730-744.

Coastal Ecosystems

Borchert, S. M., Osland, M. J., Enwright, N. M., & Griffith, K. T. (2018). Coastal wetland adaptation to sea level rise: Quantifying potential for landward migration and coastal squeeze. Journal of applied ecology, 55(6), 2876-2887.

Gabler, C. A., Osland, M. J., Grace, J. B., Stagg, C. L., Day, R. H., Hartley, S. B., Enwright, N.M., From, A.S., McCoy, M.L. & McLeod, J. L. (2017). Macroclimatic change expected to transform coastal wetland ecosystems this century. Nature Climate Change, 7(2), 142.

Kirwan, M. L., & Gedan, K. B. (2019). Sea-level driven land conversion and the formation of ghost forests. Nature Climate Change, 9(6), 450.

Taillie, P. J., Moorman, C. E., Poulter, B., Ardón, M., & Emanuel, R. E. (2019). Decadal-Scale Vegetation Change Driven by Salinity at Leading Edge of Rising Sea Level. Ecosystems, 1-13.

Tully, K., Gedan, K., Epanchin-Niell, R., Strong, A., Bernhardt, E. S., BenDor, T., Mitchell, M., Kominoski, J., Jordan, T.E., Neubauer, S.C. & Weston, N. B. (2019). The Invisible Flood: The Chemistry, Ecology, and Social Implications of Coastal Saltwater Intrusion. BioScience, 69(5), 368-378.

Animal Communities

DeMay, S. M., & Walters, J. R. (2019). Variable effects of a changing climate on lay dates and productivity across the range of the Red-cockaded Woodpecker. The Condor.

Gabler, C. A., Osland, M. J., Grace, J. B., Stagg, C. L., Day, R. H., Hartley, S. B., Enwright, N.M., From, A.S., McCoy, M.L. & McLeod, J. L. (2017). Macroclimatic change expected to transform coastal wetland ecosystems this century. Nature Climate Change, 7(2), 142.

Gade, M. R., & Peterman, W. E. (2019). Multiple environmental gradients influence the distribution and abundance of a key forest-health indicator species in the Southern Appalachian Mountains, USA. Landscape Ecology, 34(3), 569-582.

Grant, E. H. C., Brand, A. B., De Wekker, S. F., Lee, T. R., & Wofford, J. E. (2018). Evidence that climate sets the lower elevation range limit in a high-elevation endemic salamander. Ecology and evolution, 8(15), 7553-7562.

Hoffacker, M. L., Cecala, K. K., Ennen, J. R., Mitchell, S. M., & Davenport, J. M. (2018). Interspecific interactions are conditional on temperature in an Appalachian stream salamander community. Oecologia, 188(2), 623-631.

Jacobsen, C. D., Brown, D. J., Flint, W. D., Pauley, T. K., Buhlmann, K. A., & Mitchell, J. C. (2020). Vulnerability of high- elevation endemic salamanders to climate change: A case study with the Cow Knob Salamander (Plethodon punctatus). Global Ecology and Conservation, 21, e00883.

Troia, M. J., & Giam, X. (2019). Extreme heat events and the vulnerability of endemic montane fishes to climate change. Ecography.

Spooner, F. E. B., Pearson, R. G. & Freeman, R. (2018). Rapid warming is associated with population decline among terrestrial birds and mammals globally. Global Change Biology, 24:4521–4531. DOI: 10.1111/gcb.14361

Extreme Weather

Emanuel, K. (2017). Assessing the present and future probability of Hurricane Harvey's rainfall. Proceedings of the National Academy of Sciences, 114(48), 12681-12684.

Delphin, S., Escobedo, F. J., Abd-Elrahman, A., & Cropper Jr, W. (2013). Mapping potential carbon and timber losses from hurri-canes using a decision tree and ecosystem services driver mod-el. Journal of Environmental Management, 129, 599-607.

Fill, J. M., Davis, C. N., & Crandall, R. M. (2019). Climate change lengthens southeastern USA lightning-ignited fire seasons. Global change biology.

Hu, H., Wang, G. G., Bauerle, W. L., & Klos, R. J. (2017). Drought impact on forest regeneration in the Southeast USA. Ecosphere, 8(4), e01772.

Knutson, T. R., McBride, J. L., Chan, J., Emanuel, K., Holland, G., Landsea, C., Held, I., Kossin, J. P., Srivastava, A. K., & Sugi, M. (2010). Tropical cyclones and climate change. Nature Geosci-ence, 3(3), 157-163. doi:10.1038/ngeo779

McNulty, S., Baca, A., Bowker, M., Brantley, S., Dreaden, T., Golladay, S. W., ... & Mayfeld, A. (2019). Managing Effects of Drought in the Southeast United States. In: Vose, James M.; Peterson, David L.; Luce, Charles H.; Patel-Weynand, Toral, eds. Effects of drought on forests and rangelands in the United States: translating science into management responses. Gen. Tech. Rep. WO-98. Washington, DC: US Department of Agriculture, Forest Service, Washington Office. 191-220. Chapter 9., 191-220.

Mitchell, R. J., Liu, Y., O'Brien, J. J., Elliott, K. J., Starr, G., Miniat, C. F., & Hiers, J. K. (2014). Future climate and fire interactions in the southeastern region of the United States. Forest Ecology and Management, 327, 316-326.

Schwantes, A. M., Swenson, J. J., González-Roglich, M., Johnson, D. M., Domec, J. C., & Jackson, R. B. (2017). Measuring canopy loss and climatic thresholds from an extreme drought along a fivefold precipitation gradient across Texas. Global change biology, 23(12), 5120-5135.

Seneviratne, S. I., Nicholls, N., Easterling, D., Goodess, C.M., Kanae, S., Kossin, J., ... & Zhang, X. (2012). Changes in Climate extremes and their impacts on the natural physical environment. In: Field, C.B et al. (Eds.), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge, UK, and New York, NY, USA: Cambridge University Press, 109-230.

Stambaugh, M. C., Guyette, R. P., Stroh, E. D., Struckhoff, M. A., & Whittier, J. B. (2018). Future southcentral US wildfire probability due to climate change. Climatic change, 147(3-4), 617-631.

Stroh, E. D., Struckhoff, M. A., Stambaugh, M. C., & Guyette, R. P. (2018). Fire and Climate Suitability for Woody Vegetation Communities in the South Central United States. Fire Ecology, 14(1), 106-124.

Trenberth, K. E., Cheng, L., Jacobs, P., Zhang, Y., & Fasullo, J. (2018). Hurricane Harvey links to ocean heat content and climate change adaptation. Earth's Future, 6(5), 730-744.

Water Resources

Erwin, K. L. (2009). Wetlands and global climate change: the role of wetland restoration in a changing world. Wetlands Ecology and Management, 17(1), 71-84. doi:10.1007/s11273-008-9111

McNulty, S., Baca, A., Bowker, M., Brantley, S., Dreaden, T., Golladay, S. W., ... & Mayfeld, A. (2019). Managing Effects of Drought in the Southeast United States. In: Vose, James M.; Peterson, David L.; Luce, Charles H.; Patel-Weynand, Toral, eds. Effects of drought on forests and rangelands in the United States: translating science into management responses. Gen. Tech. Rep. WO-98. Washington, DC: US Department of Agriculture, Forest Service, Washington Office. 191-220. Chapter 9., 191-220.

Schwantes, A. M., Swenson, J. J., González-Roglich, M., Johnson, D. M., Domec, J. C., & Jackson, R. B. (2017). Measuring canopy loss and climatic thresholds from an extreme drought along a fivefold precipitation gradient across Texas. Global change biology, 23(12), 5120-5135.

Trenberth, K. E., Cheng, L., Jacobs, P., Zhang, Y., & Fasullo, J. (2018). Hurricane Harvey links to ocean heat content and climate change adaptation. Earth's Future, 6(5), 730-744.

Recreation

Boyer, T. A., Melstrom, R. T., & Sanders, L. D. (2017). Effects of climate variation and water levels on reservoir recreation. Lake and reservoir management, 33(3), 223-233.

Luber, G., K. Knowlton, J. Balbus, H. Frumkin, M. Hayden, J. Hess, M. McGeehin, N. Sheats, L. Backer, C. B. Beard, K. L. Ebi, E. Maibach, R. S. Ostfeld, C. Wiedinmyer, E. Zielinski-Gutiérrez, & L. Ziska, (2014). Ch. 9: Human Health. Climate Change Im- pacts in the United States: The Third National Climate Assessment, U.S. Global Change Research Program, 220-256.

McNulty, S., Baca, A., Bowker, M., Brantley, S., Dreaden, T., Golladay, S. W., ... & Mayfeld, A. (2019). Managing Effects of Drought in the Southeast United States. In: Vose, James M.; Peterson, David L.; Luce, Charles H.; Patel-Weynand, Toral, eds. Effects of drought on forests and rangelands in the United States: translating science into management responses. Gen. Tech. Rep. WO-98. Washington, DC: US Department of Agriculture, Forest Service, Washington Office. 191-220. Chapter 9., 191-220.