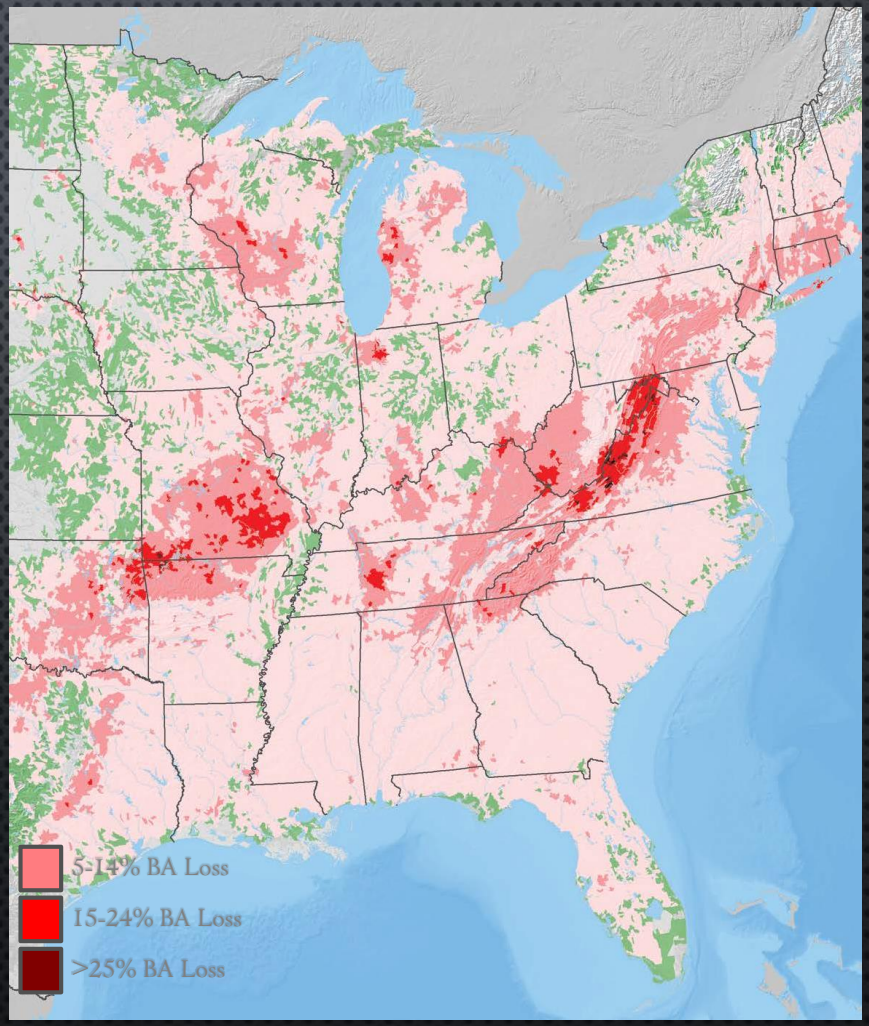
OAK DECLINE

IN THE EASTERN UNITED STATES

Ryan A. Blaedow
Forest Health Protection
USDA Forest Service
October 9, 2019

Oak Decline

In the Eastern United States



Risk Map: Percent Total Basal Area Loss by Watershed through 2027
Source: 2013-2027 National Insect and Disease Forest Risk Assessment

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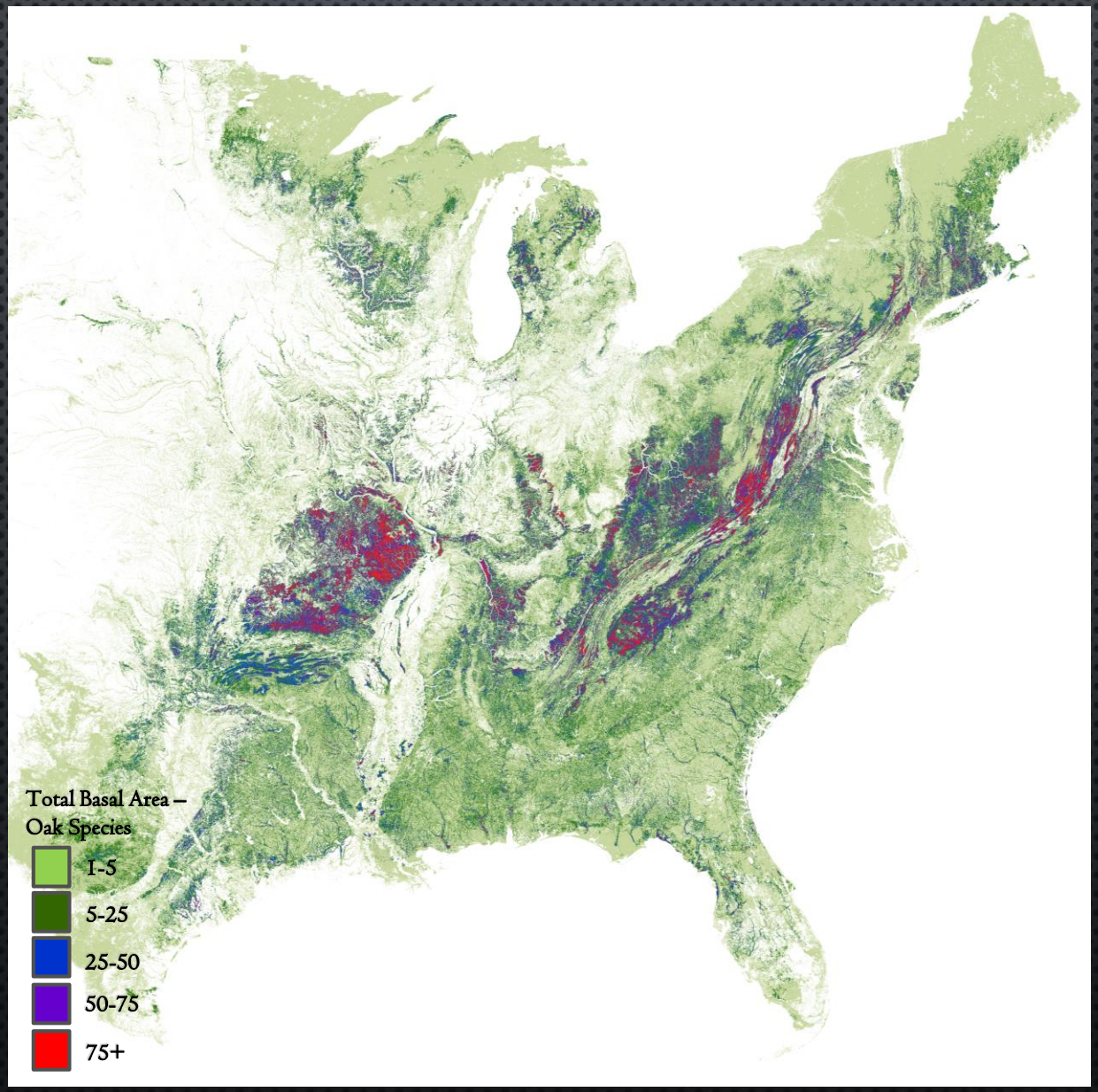

Total basal area of oak in the eastern U.S.
USFS Individual Tree Species Parameter Maps, NIDRM 2012

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Historic disturbance regimes, chestnut blight, logging, and fire suppression have resulted in physiologically mature oak dominated forests in the eastern U.S.

From: S.W. Oak et al. 2016. Oak Decline in Central Hardwood Forests: Frequency, Spatial Extent, and Scale

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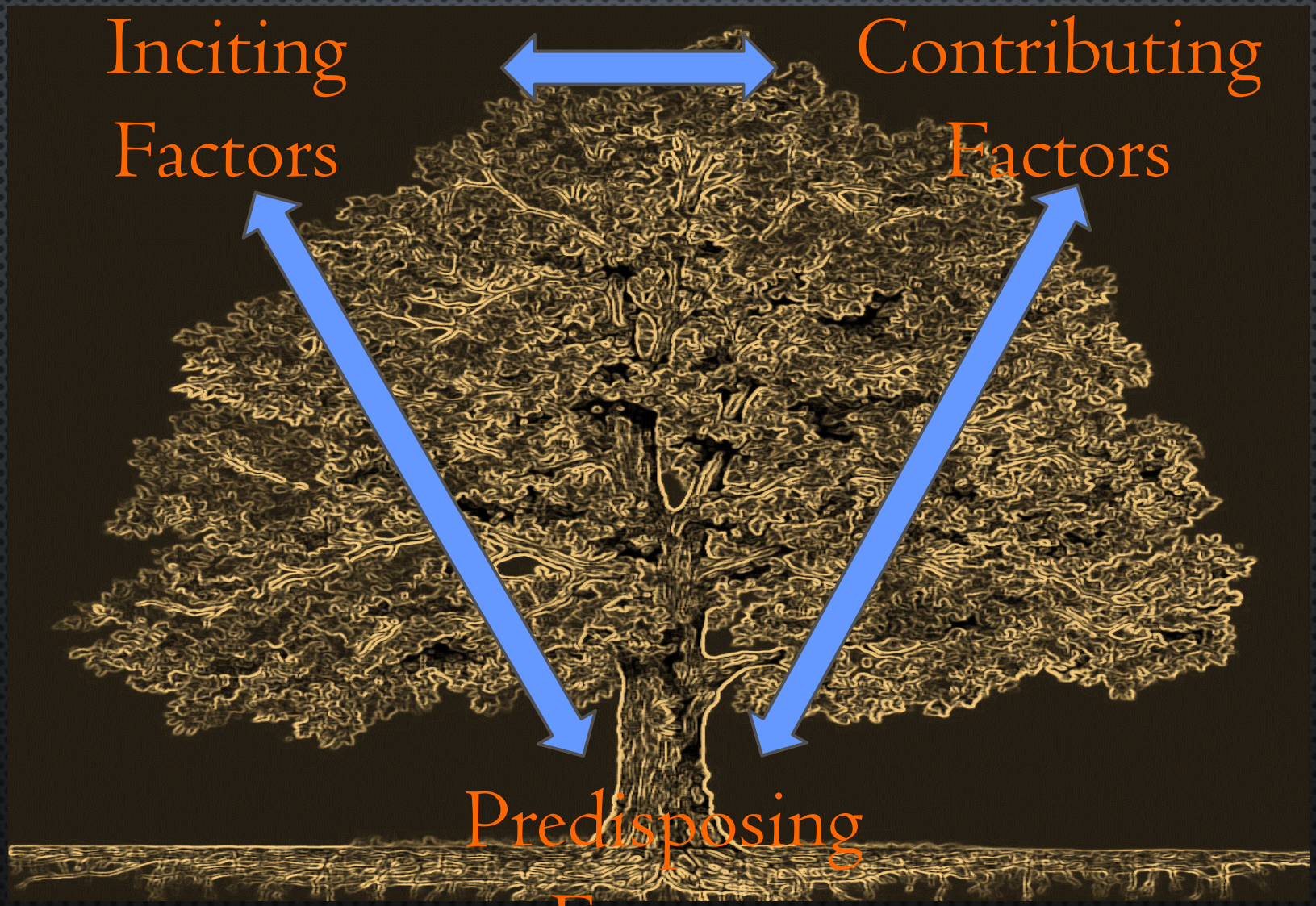

From: Manion, P.D. 1991. Tree Disease Concepts
& W.A. Sinclair. 1995. Comparisons of recent declines of white ash, oaks, and sugar maple in northeastern woodlands

Oak Decline

In the Eastern United States

Predisposing Factors

- ✓ Soil Depth
- ✓ Soil Texture
- ✓ Nutrient Deficiency
- ✓ Slope
- ✓ Aspect
- ✓ Physiological Age
- ✓ Stocking Levels
- ✓ Competition

Oak Decline

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Inciting Factors

- ✓ Drought
- ✓ Defoliation
- ✓ Late Spring Frosts
- ✓ Flooding
- ✓ Fire
- ✓ Construction Injury
- ✓ Wind
- ✓ Hail

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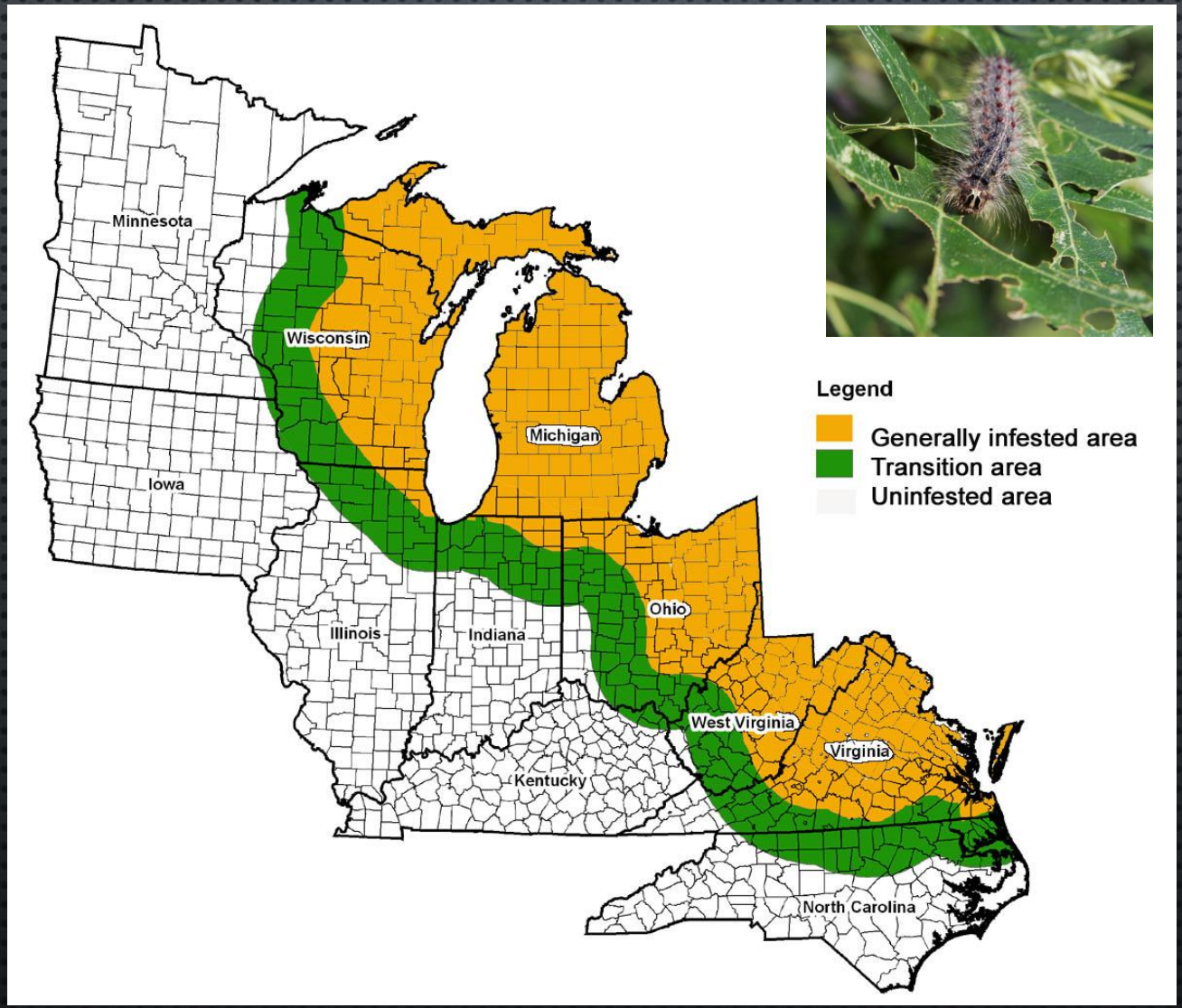
In the Eastern United States



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In the Eastern United States

Chris Asaro, Oak Mortality, Poor Mountain, Roanoke Co., 2009

Oak Decline

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Inciting Factors

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Contributing Factors

- ✓ Armillaria Root Disease
- ✓ Hypoxylon Canker
- ✓ Red Oak Borer
- ✓ Two Lined Chestnut Borer
- ✓ Bacterial Leaf Scorch

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Chris Asaro, USDA Forest Service

Red Oaks

White Oaks

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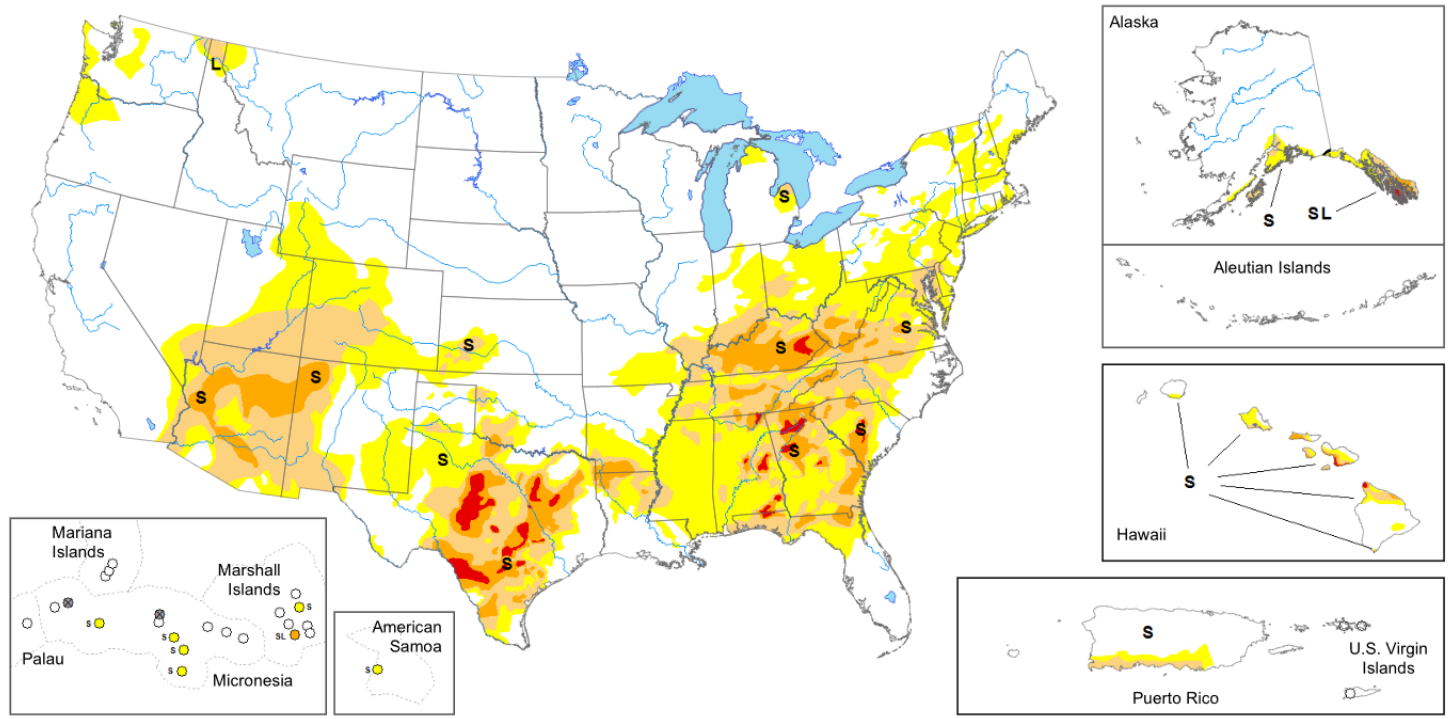
Map released: October 3, 2019

Data valid: October 1, 2019



United States and Puerto Rico Author(s):
***Brian Fuchs**, National Drought Mitigation Center*

U.S. Affiliated Pacific Islands and Virgin Islands Author(s):
***Ahira Sanchez-Lugo**, NOAA/NCEI*

The data cutoff for Drought Monitor maps is each Tuesday at 8 a.m. EDT. The maps, which are based on analysis of the data, are released each Thursday at 8:30 a.m. Eastern Time.

Intensity and Impacts

- **None**
- **D0** (Abnormally Dry)
- **D1** (Moderate Drought)
- **D2** (Severe Drought)
- **D3** (Extreme Drought)
- **D4** (Exceptional Drought)
- **No Data**

~ - Delineates dominant impacts

S - Short-Term impacts, typically less than 6 months (e.g. agriculture, grasslands)

L - Long-Term impacts, typically greater than 6 months (e.g. hydrology, ecology)

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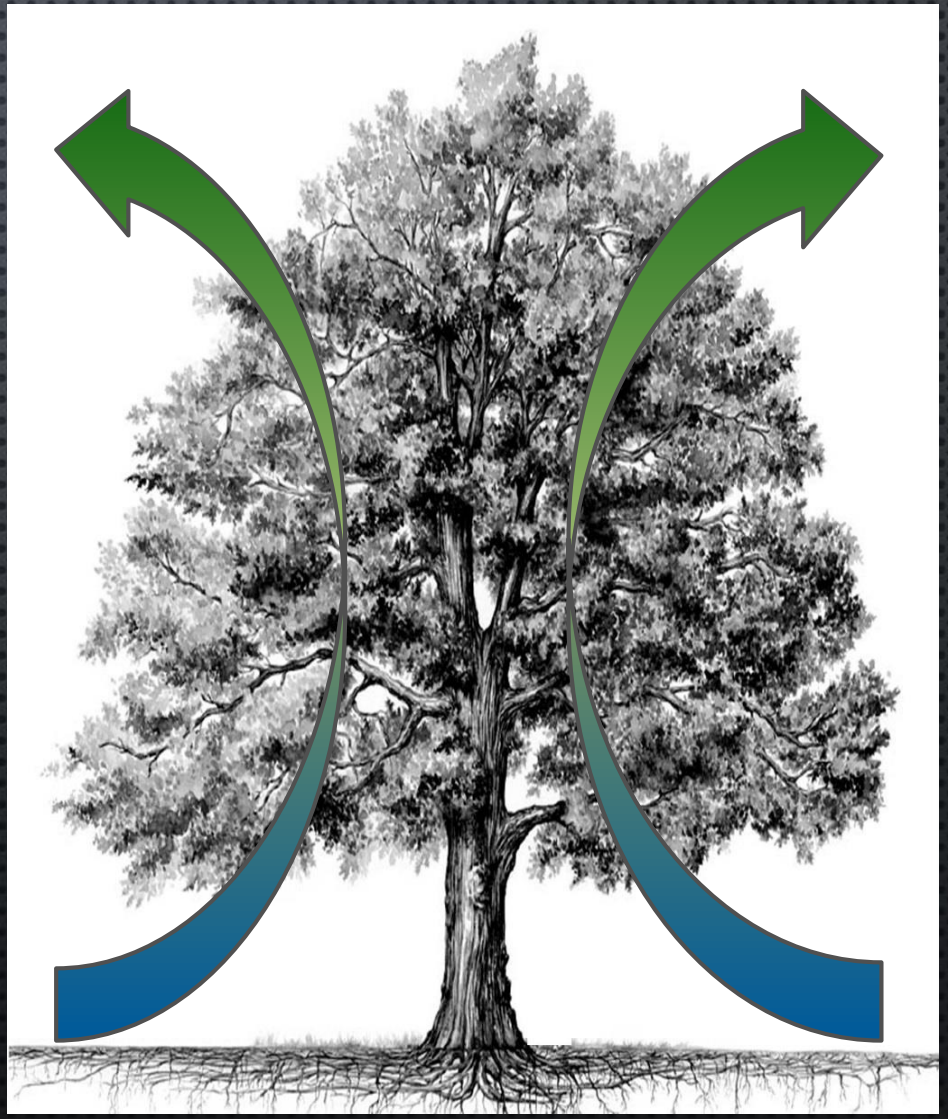
- ✓ Respiration
- ✓ Photosynthesis
- ✓ Translocation



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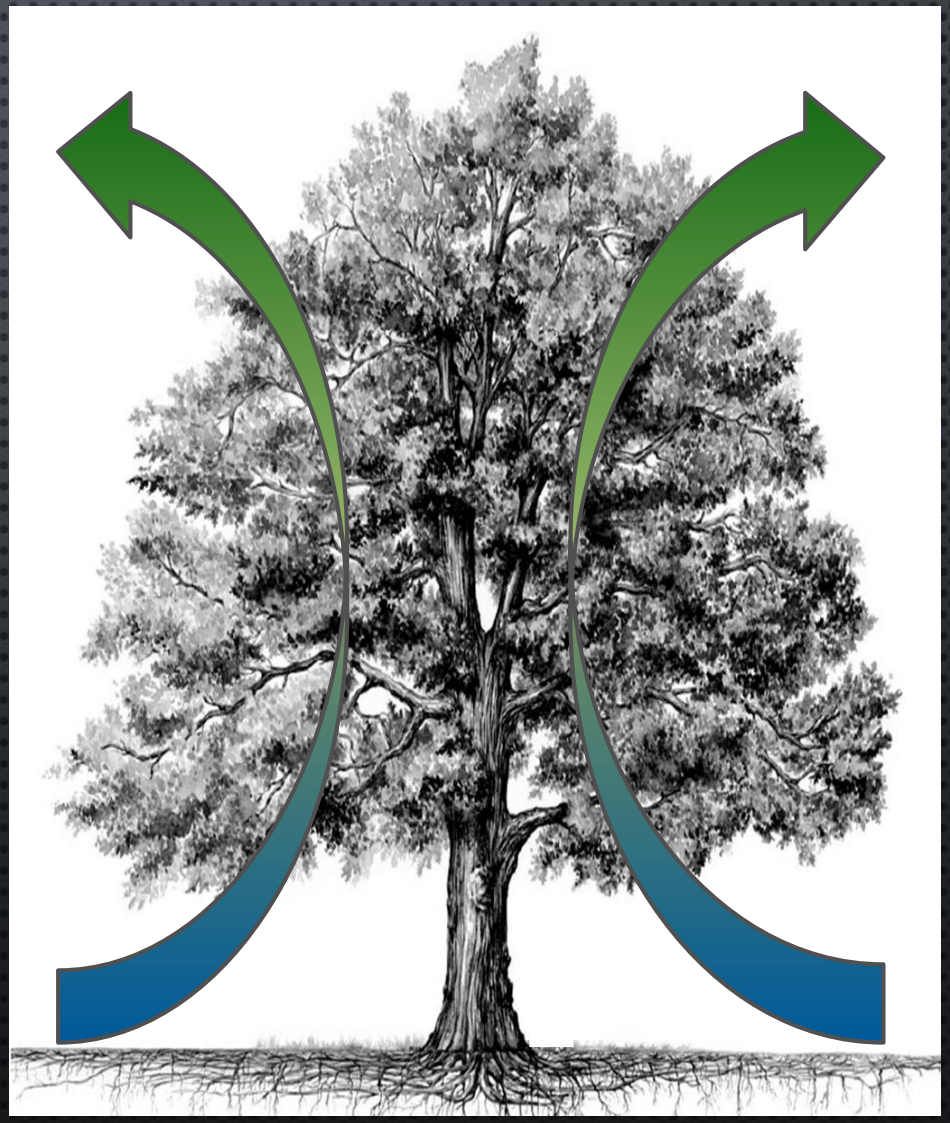
1) Maintenance of living tissues
2) Production of fine roots
3) Flower and seed production
4) Primary Growth
5) Secondary Growth



From: D. Mercker and G. Hopper. 2004. Why do Trees Die?

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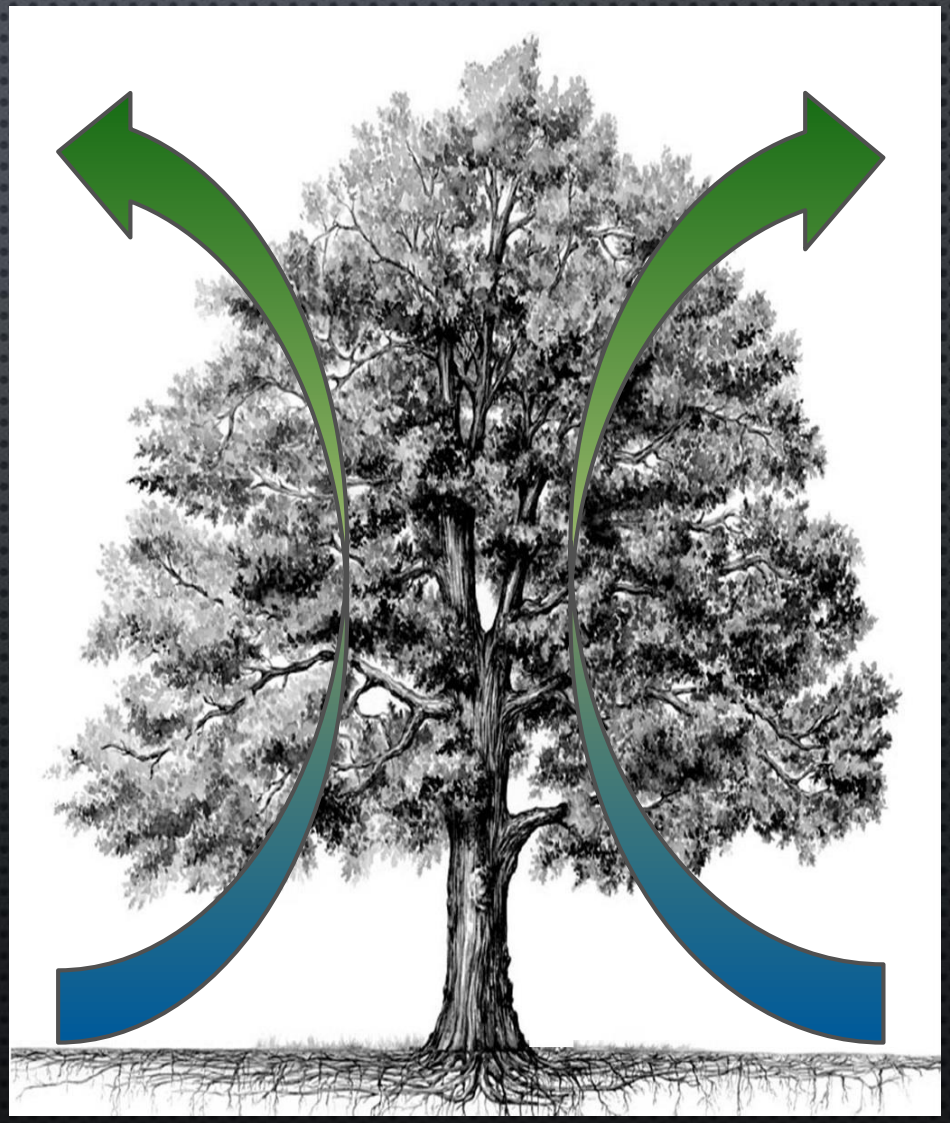

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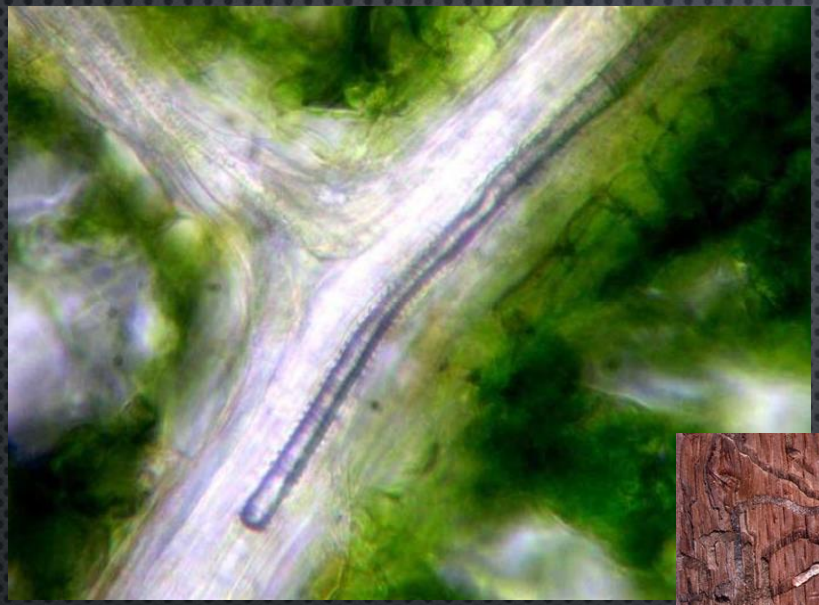


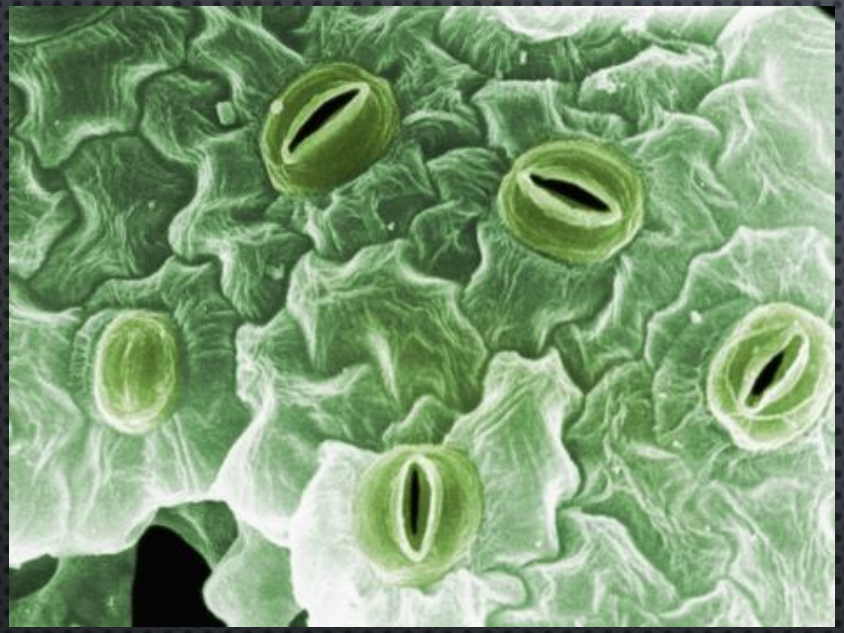
Cavitation

Attack

Starvation

From: McDowell et al. 2008 Mechanisms of Plant Survival and Mortality During Drought

Isohydry vs Anisohydry

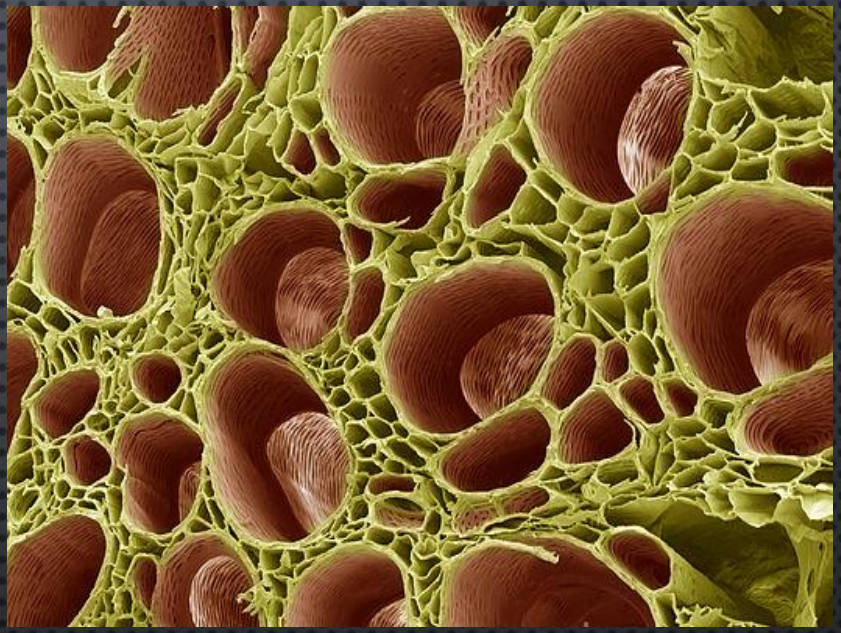


Isohydric Plants

Maintain more constant water potentials by closing stomata when water stress is sensed

Increased risk of Carbon Starvation due to slow stomatal recovery

Poorly adapted for prolonged or fluctuating droughts



Anisohydric Plants

Tolerate low very low water potenitals in favor of maintaining CO_2 assimilation

Increased Risk of Cavitation due to very low water potentials

Poorly adapted for severe droughts

From: McDowell et al. 2008 Mechanisms of Plant Survival and Mortality During Drought

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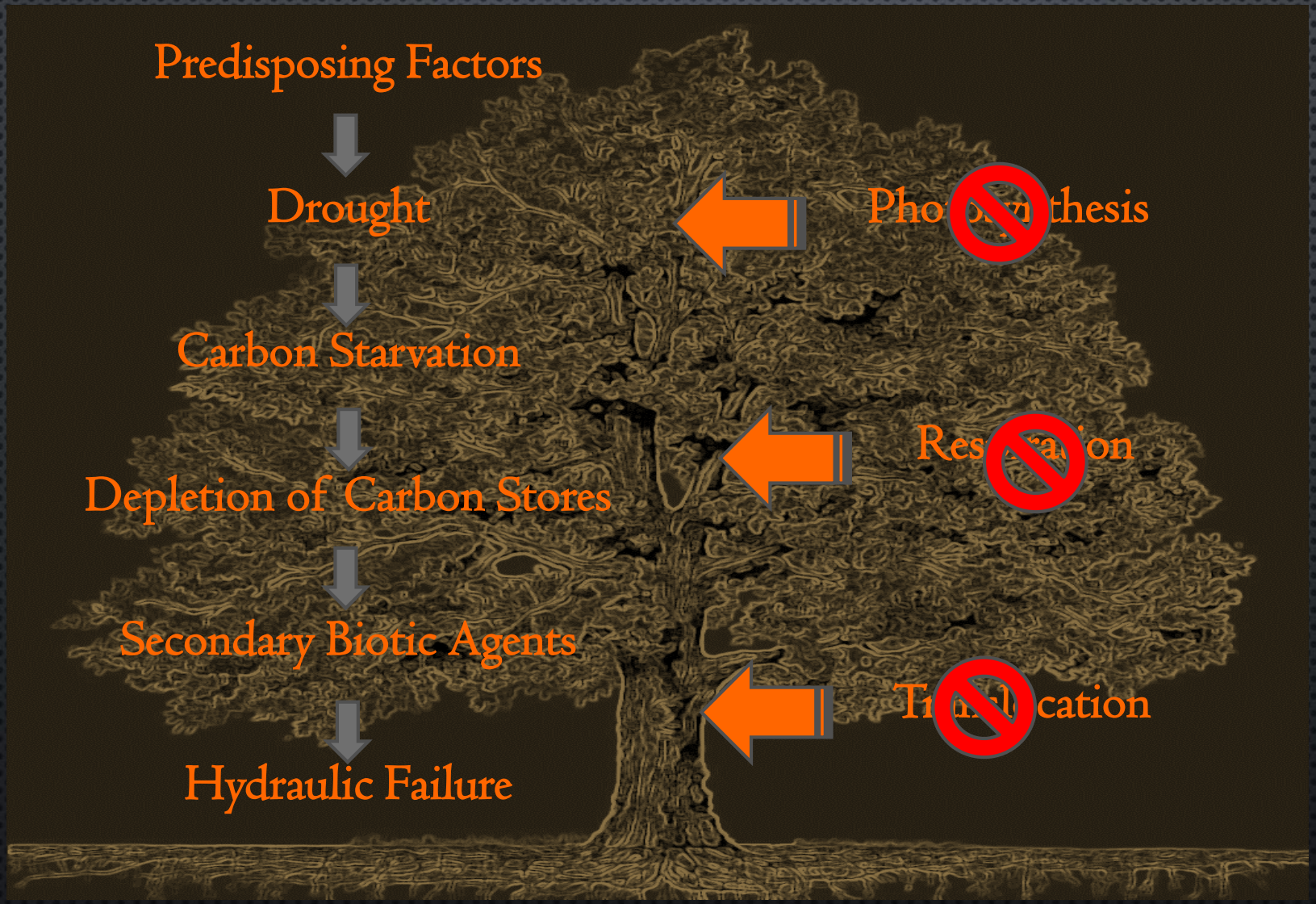

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Chris Asaro, USDA Forest Service

Key to Survival

- ✓ High growth rate?
- ✓ High root : leaf area?
- ✓ Extensive root system?
- ✓ Carbon allocation to defense?
- ✓ Abundant earlywood vessels?
- ✓ Smaller annual growth increment?
- ✓ Small vascular elements?
- ✓ Previous exposure to drought?
- ✓ Adequate recovery time?
- ✓ Mesic sites?
- ✓ Xeric sites?

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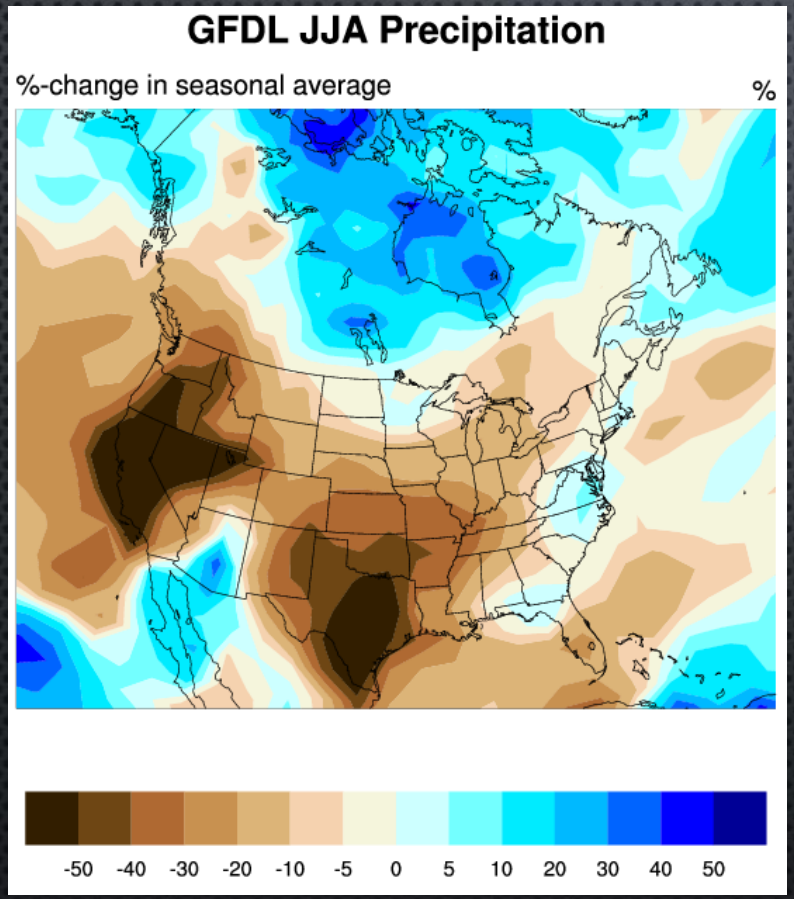

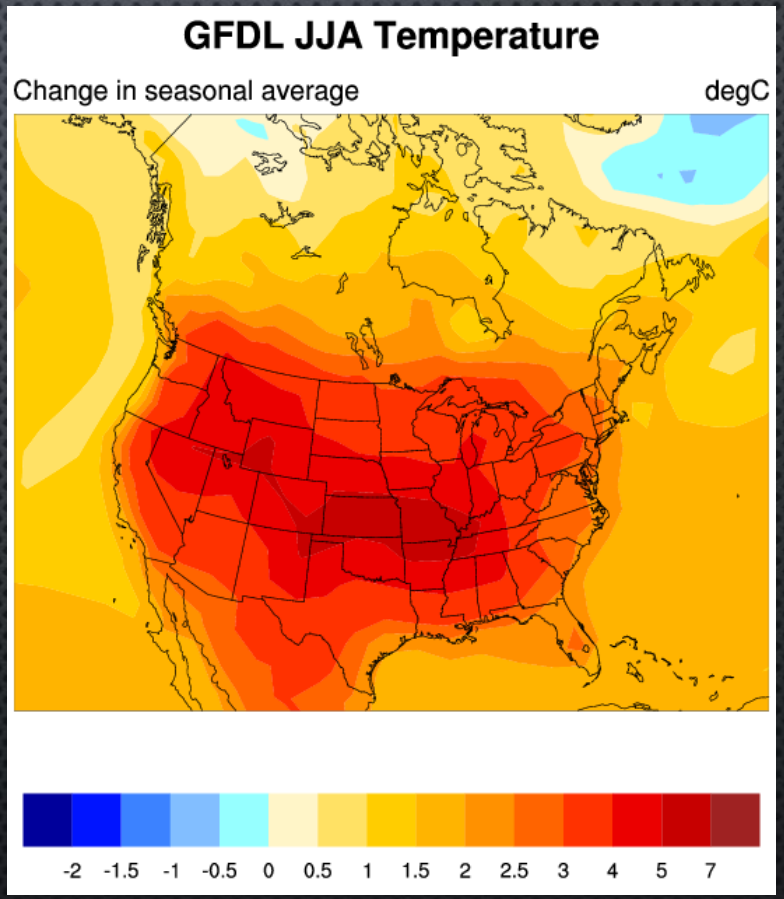

These figures show seasonal average climate change for the periods 2041-2070 minus 1971-2000 for the GFDL driving AOGCM and for the ECP2 regional model driven with GFDL boundary conditions
Source: North American Regional Climate Change Assessment Program

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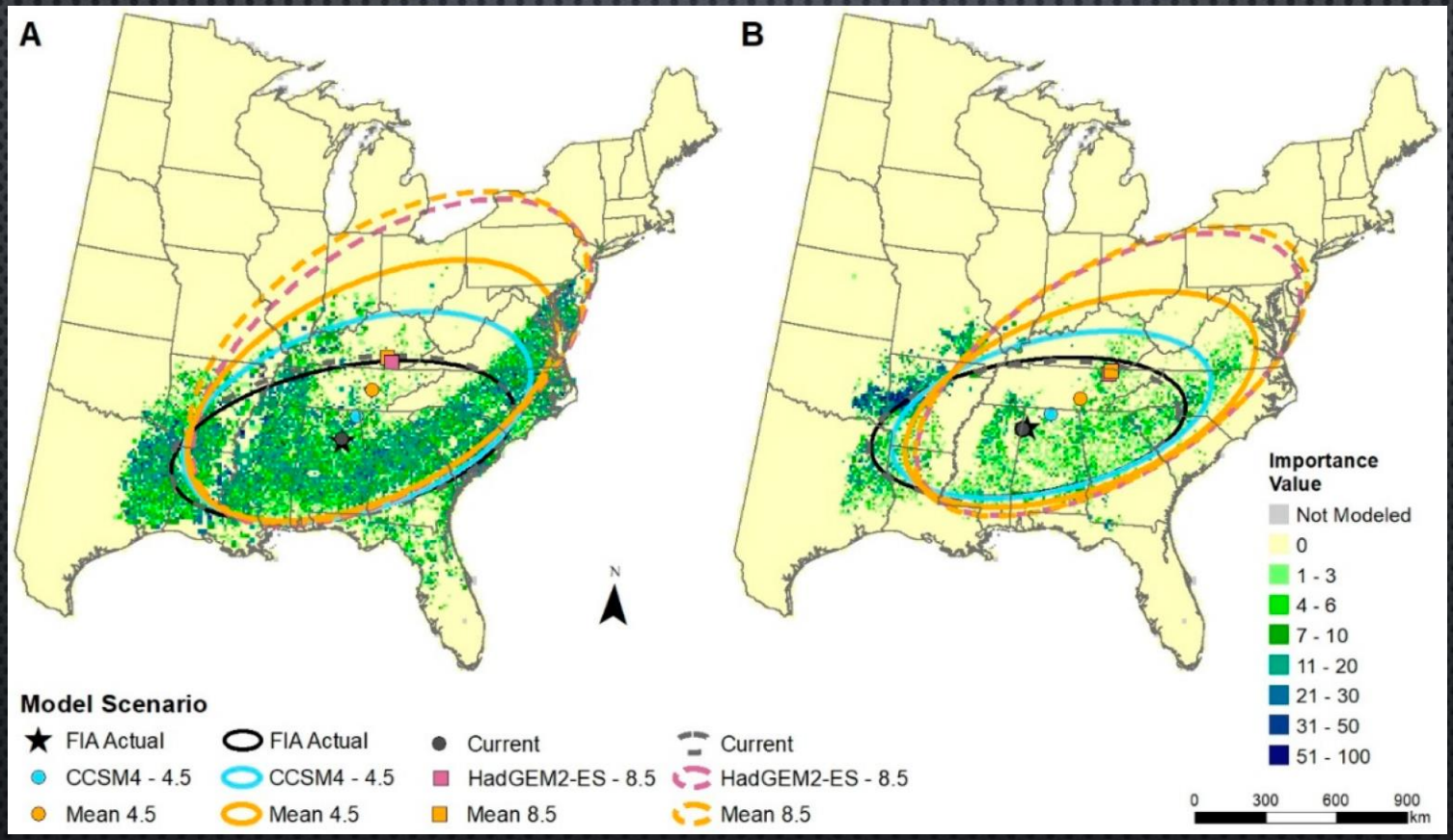

Example: current distribution of tree species and projected future suitable habitat under several climate change models
Iverson et al. 2019. Analysis of Climate Change Impacts on Tree Species of the Eastern U.S.

Management Options

- ✓ Risk Rating Systems
- ✓ Localized management plans
- ✓ Conversion to decline resistant, more resilient species
- ✓ Selection for drought resistant individuals
- ✓ Retain or regenerate?
- ✓ Supplementing natural regen
- ✓ Partial cutting, thinning
- ✓ Proper tree care
- ✓ Natural selection
- ✓ Research

From: S.W. Oak et al. 2016. Oak Decline in Central Hardwood Forests: Frequency, Spatial Extent, and Scale

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Relevant Literature and Citations

- Abrams, M.D. 1990. Adaptations and responses to drought in Quercus species of North America. *Tree Physiology* 7: 227-238.
- Allen, C.D. et al. 2010. A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management* 259: 660-684.
- Fan, Z. et al. 2012. Spatio-Temporal Trends of Oak Decline and Mortality under Periodic Regional drought in the Ozark Highlands of Arkansas and Missouri. *Forests* 3: 614-631.
- Haavik, L.J. et al. 2015. Emergent insects, pathogens, and drought shape changing patterns in oak decline in North America and Europe. *Forest Ecology and Management* 354: 190-205.
- Iverson, I.R. et al. 2019. Analysis of Climate Change Impacts on Tree Species of the Eastern U.S.: Results of DISTRIB-II Modeling. *Forests* 10 (4): 302.
- Juzwik, J. and T.L. Schmidt. 2000. Oak Wilt and Oak Decline in the Upper Midwest. *Recent Advances on Oak Health in Europe* pp 139-145.
- Knott, J.A. et al. 2018. Shifts in forest composition in the eastern United States. *Forest Ecology and Management* 433: 176-183.
- Manion, P.D. 1991. *Tree Disease Concepts* (2nd Edition, pp 328-348. Englewood Cliffs: Prentice Hall.
- McDowell, N. et al. 2008. 2008 Mechanisms of Plant Survival and Mortality During Drought: why do some plants survive while others succumb to drought? Tansley review. *New Phytologist* 178, 917-739.
- McEwan, R.W., J.M. Dyer, and N. Pederson. 2011. Multiple interacting ecosystem drivers: toward an encompassing hypothesis of oak forest dynamics across eastern North America. *Ecography* 34: 244-256.
- McNab, W.H. et al. 2014. Climate-Induced Migration of Native Tree Populations and Consequences for Forest Health. *A guide for natural resource managers in southern forest ecosystems.* CRC Press - Taylor and Francis pp. 307 – 378.
- Mercker, D. and G. Hopper. 2004. Why do Trees Die. University of Tennessee Agricultural Extension Service SP 615.
- Oak, S.W., M.A. Spetich, and R.S. Morin. 2016. Oak decline in Central Hardwood Forests: Frequency, Spatial Extent, and Scale. *Natural Disturbances and Historic Range of Variation.* Springer International Publishing pp. 49-71.
- Seager, R., A. Tzanova, and J. Nakamura. 2009. Drought in the Southeastern United States: Causes, Variability over the Last Millenium, and Potential for Future Hydroclimate Change. Journal of Climate 22: 5021- 5045.
- Sinclair, W.A. 1965. Comparisons of recent Declines of White Ash, Oaks, and Sugar Maple in Northeastern Woodlands. *Cornell Plantations,* 20, 62-67.
- Spetich, M.A. et al. 2016. Oak Decline Across the Ozark Highlands – From Stand to Landscape and Regional Scale Processes. *Proceedings of the 18th Biennial Southern Silvicultural Research Conference. E-Gen. Tech. Rep SRS 212* 614p.
- Starkey, D.A. et al. 1989. Evaluation of Oak decline Areas in the South. US Forest Service Southern Region Protection Report R8-PR 17.

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