

Extreme Weather, Climate Variability & the U.S Fish and Wildlife Service



Part I. Drought

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Introduction

Drought is a natural part of the landscape in many regions of the United States (USA). The USA has experienced periodic, severe droughts over many millennia, as documented by paleoclimatic evidence (<http://search.proquest.com/docview/232628269?pq-origsite=gscholar>).

In the 20th and 21st centuries, extensive droughts were experienced in the 1930s, 1950s, 1980s and 2010s. The Dust Bowl of the 1930s has been characterized as the worst drought in the USA in a millennium: (<http://onlinelibrary.wiley.com/doi/10.1002/2014GL061661/epdf>).

Some evidence indicates that drought conditions over the past 30+ years have been increasing in some parts of the USA while decreasing in other parts of the USA (e.g., <http://iopscience.iop.org/article/10.1088/1748-9326/10/4/044009>). Drought risk for parts of the USA is projected to increase considerably over the 21st Century according to modeling results of some researchers (e.g., <http://advances.sciencemag.org/content/1/1/e1400082>).

This “mini” resource paper provides a small sample of the extensive recent literature related to drought in North America, with specific emphasis on the USA. Topics include: general resources; drought observations in the USA (including drought history reconstructions); projected drought in coming decades; current and projected drought impacts to natural resources in the USA; and responses by Service managers and other natural resource managers to drought impacts. These papers may be of interest to Service managers, planners and researchers interested in the impact of drought on trust resources and in projections for future droughts and impacts. Although the following list is not exhaustive by any means, the papers herein have extensive literature cited sections that will be useful for those interested in additional information.

This Resource Paper will be updated periodically. If you have additional examples, please send to Kurt Johnson (kurt_johnson@fws.gov).

General Resources

The US Drought Portal provides a variety of resources:

<https://www.drought.gov/drought/>.

USGS has a web page devoted to the ongoing drought in California:

<http://ca.water.usgs.gov/data/drought/index.html>.

NOAA's "State of the Climate" web page discusses ongoing droughts in the US:

<https://www.ncdc.noaa.gov/sotc/drought/201610>

The SE Regional Climate Center provides updates on the ongoing drought in the Southeast:

http://www.sercc.com/SERCC_drought_report_Oct_2016.pdf

Drought Observations

Darren L Ficklin, Justin T Maxwell, Sally L Letsinger, and Hamed Gholizadeh. 2015. A climatic deconstruction of recent drought trends in the United States. *Environmental Research Letters* Volume 10, Number 4. <http://iopscience.iop.org/article/10.1088/1748-9326/10/4/044009>

B. I. Cook, E. R. Cook, J. E. Smerdon, R. Seager, A. P. Williams, S. Coats, D. W. Stahle, J. Villanueva Díaz. 2016. North American megadroughts in the Common Era: Reconstructions and simulations. *Wiley Interdiscip. Rev. Clim. Change* 7, 411–432
http://www.ldeo.columbia.edu/~jsmerdon/papers/2016_wirescc_cooketal.pdf

C. A. Woodhouse and J. T. Overpeck. 1998. 2000 years of drought variability in the central United States. *Bull. Am. Meteorol. Soc.* 79, 2693–2714.
<https://www.ncdc.noaa.gov/paleo/amsdrought.pdf>

E. R. Cook, C. A. Woodhouse, C. M. Eakin, D. M. Meko, D. W. Stahle. 2004. Long-term aridity changes in the western United States. *Science* 306, 1015–1018
<http://science.sciencemag.org/content/306/5698/1015>

S. Coats, J. E. Smerdon, R. Seager, B. I. Cook, J. F. González-Rouco. 2013. Megadroughts in Southwestern North America in ECHO-G millennial simulations and their comparison to proxy drought reconstructions. *J. Climate* 26, 7635–7649.
<http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00603.1>

Funk, C., A. Hoell, and D. Stone. 2014. Examining the contribution of the observed global warming trend to the California droughts of 2012/13 and 2013/14 [in "Explaining Extremes of 2013 from a Climate Perspective"]. *Bull. Amer. Meteor. Soc.*, **95**, S11–S15.

<https://www2.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/explaining-extreme-events-of-2013-from-a-climate-perspective/>

L. Cheng, M. Hoerling, A. AghaKouchak, B. Livneh, X.-W. Quan, J. Eischeid. 2016. How has human-induced climate change affected California drought risk? *J. Climate* 10.1175/JCLI-D-15-0260.1. <http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-15-0260.1>

N Pederson, A R Bell, T A Knight, C Leland, N Malcomb, K J Anchukaitis, K Tackett, J Scheff, A Brice, B Catron, W Blozan and J Riddle. 2012. A long-term perspective on a modern drought in the American Southeast. *Environ. Res. Lett.* 7: 014034 (8pp)
<http://iopscience.iop.org/article/10.1088/1748-9326/7/1/014034/meta>

Drought Projections

R. Seager, M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H.-P. Huang, N. Harnik, A. Leetmaa, N.-C. Lau, C. Li, J. Velez, N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. *Science* 316, 1181–1184.
<http://science.sciencemag.org/content/316/5828/1181>

T. R. Ault, J. S. Mankin, B. I. Cook, J. E. Smerdon. 2016. Relative impacts of mitigation, temperature, and precipitation on 21st-century megadrought risk in the American Southwest. *Sci. Adv.* 2, e1600873. <http://advances.sciencemag.org/content/2/10/e1600873>

B. I. Cook, T. R. Ault, J. E. Smerdon. 2015. Unprecedented 21st century drought risk in the American Southwest and Central Plains. *Sci. Adv.* 1, e1400082.
<http://advances.sciencemag.org/content/1/1/e1400082>

T. R. Ault, J. E. Cole, J. T. Overpeck, G. T. Pederson, D. M. Meko. 2014. Assessing the risk of persistent drought using climate model simulations and paleoclimate data. *J. Clim.* 27, 7529–7549. <http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00282.1>

B. I. Cook, J. E. Smerdon, R. Seager, S. Coats. 2014. Global warming and 21st century drying. *Clim. Dyn.* 43, 2607–2627. <http://link.springer.com/article/10.1007/s00382-014-2075-y>

Neelin, J. D., B. Langenbrunner, J. E. Meyerson, A. Hall, and N. Berg. 2013. California winter precipitation change under global warming in the Coupled Model Intercomparison Project phase 5 ensemble. *J. Climate*, 26, 6238–6256.
<http://journals.ametsoc.org/doi/full/10.1175/JCLI-D-12-00514.1>

Drought Impacts

“The U.S. Department of Agriculture (USDA) announced today (November 18, 2016) that the U.S. Forest Service has identified an additional 36 million dead trees across California since its last aerial survey in May 2016. This brings the total number of dead trees since 2010 to over 102 million on 7.7 million acres of California's drought stricken forests. In 2016 alone, 62 million trees have died, representing more than a 100 percent increase in dead trees across the state from 2015. Millions of additional trees are weakened and expected to die in the coming months and years.” <https://content.govdelivery.com/accounts/USDAO/bulletins/1737f64>

Special section: Drought and US Forests: Impacts and Potential Management Responses. *Forest Ecology and Management*, Volume 380, Pages 1-358 (15 November 2016)
<http://www.sciencedirect.com/science/journal/03781127/380/supp/C>

Drought on Rangelands: Effects and Solutions. *Rangelands*, Volume 38, Issue 4, Pages 159-232 (August 2016) <http://www.sciencedirect.com/science/journal/01900528/38/4>

Vose, J.M., Clark, J.S., Luce, C.H., Patel-Weynand, T., eds. 2016. Effects of drought on forests and rangelands in the United States: a comprehensive science synthesis. Gen. Tech. Rep. WO-93b. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. 289 p.
http://www.fs.fed.us/sites/default/files/DROUGHT_book-web-1-11-16.pdf

Peltier, D. M. P., Fell, M. and Ogle, K. 2016. Legacy effects of drought in the southwestern United States: A multi-species synthesis. *Ecol Monogr*, 86: 312–326.
<http://onlinelibrary.wiley.com/doi/10.1002/ecm.1219/full>

Clark, J. S., Iverson, L., Woodall, C. W., Allen, C. D., Bell, D. M., Bragg, D. C., D'Amato, A. W., Davis, F. W., Hersh, M. H., Ibanez, I., Jackson, S. T., Matthews, S., Pederson, N., Peters, M., Schwartz, M. W., Waring, K. M. and Zimmermann, N. E. 2016. The impacts of increasing drought on forest dynamics, structure, and biodiversity in the United States. *Glob Change Biol*, 22: 2329–2352. <http://onlinelibrary.wiley.com/doi/10.1111/gcb.13160/abstract>

A. Park Williams, Craig D. Allen , Constance I. Millar, Thomas W. Swetnam , Joel Michaelsen , Christopher J. Still , and Steven W. Leavitt. 2010. Forest responses to increasing aridity and warmth in the southwestern United States. *PNAS* 107(50): 21289–21294.
<http://www.pnas.org/content/107/50/21289.full.pdf>

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<http://www.sciencedirect.com/science/article/pii/S0378112716303589>

Dario Martin-Benito and Neil Pederson. 2015. Convergence in drought stress, but a divergence of climatic drivers across a latitudinal gradient in a temperate broadleaf forest. *Journal of Biogeography* 42: 925–937. <http://onlinelibrary.wiley.com/doi/10.1111/jbi.12462/abstract>

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Dahl, T.E. 2014. Status and trends of prairie wetlands in the United States 1997 to 2009. U.S. Department of the Interior; Fish and Wildlife Service, Ecological Services, Washington, D.C. (67 pages). <https://www.fws.gov/wetlands/Documents/Status-and-Trends-of-Prairie-Wetlands-in-the-United-States-1997-to-2009.pdf>

Tristan Ballard, Richard Seager, Jason E. Smerdon, Benjamin I. Cook, Andrea J. Ray, Balaji Rajagopalan, Yochanan Kushnir, Jennifer Nakamura, and Naomi Henderson. 2014. Hydroclimate Variability and Change in the Prairie Pothole Region, the “Duck Factory” of North America. *Earth Interact.*, 18, 1–28. <http://dx.doi.org/10.1175/EI-D-14-0004.1>

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Stephen W. Golladay, Paula Gagnon, Margaret Kearns, Juliann M. Battle, and David W. Hicks. 2004. Response of freshwater mussel assemblages (Bivalvia: Unionidae) to a record drought in the Gulf Coastal Plain of southwestern Georgia. *Journal of the North American Benthological Society* Vol. 23, Issue 3, pg(s) 494-506. [http://www.bioone.org/doi/abs/10.1899/0887-3593\(2004\)023%3C0494%3AROFMAB%3E2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1899/0887-3593(2004)023%3C0494%3AROFMAB%3E2.0.CO%3B2)

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Chris McCreedy and Charles van Riper, III. 2015. Drought-caused delay in nesting of Sonoran Desert birds and its facilitation of parasite- and predator-mediated variation in reproductive success. *The Auk*, Vol. 132, Issue 1, pg(s) 235-247.

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Drought Response

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