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First name: Lance
Last name: Olsen
Organization:
Title:
Comments: To: Sandy Mack
From: Lance Olsen
Subject: Mid-Swan Landscape Restoration & Wildland Urban Interface Project.

I can say upfront that I've never had as much sympathy for Forest Service managers as I have now. The need of response to new climate conditions is both urgent and unprecedented, and the recent human population boom in many forested areas adds to an increasingly tricky situation. Likely never in the agency's history has the Forest Service had to think its way through such a daunting batch of (increasingly urgent) concerns.

I can also say upfront that I saw some ideas to like in the Flathead National Forest's Mid-Swan Project, including that it proposes action at a scale much more appropriate than piece by piece projects that could otherwise obscure cumulative effect, and that is upfront about making an effort to maintain and restore forest characteristics "in light of climate change."

Its emphasis on exploring "concepts" is also a good approach, given the nature of the challenges it faces. For example, "Future reference conditions were based on the range of variation of 14 watersheds with a slightly warmer and drier climate, which served as approximation for future conditions in the Mid-Swan by the middle of this century (Hessburg et al. 2013, p. 818)."

While the concept of a "slightly" warmer and drier climate is subject to doubt, the concept of warmer and drier conditions does call attention to a pairing of two new conditions which, taken together, are highly likely to have detectable and potentially important consequences for the composition and structure of National Forests "throughout the Northern Rockies," including the Flathead National Forest.

For example, "Increasing air temperature, through its influence on soil moisture, is expected to cause gradual changes in the abundance and distribution of tree, shrub, and grass species throughout the Northern Rockies, with drought tolerant species becoming more competitive."

Robert E. Keane, et al. Effects of Climate Change on Forest Vegetation in the Northern Rockies. Chapter 5 in J.E. Halofsky, D.L. Peterson (eds.), Climate Change and Rocky Mountain Ecosystems, Advances in Global Change Research 63
<<https://www.fs.fed.us/rm/pubs_journals/2018/rmrs_2018_keane_r001.pdf>>
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The above-predicted combination of increasing air temperature and drought surfaced as a particularly interesting topic in forest science with a 2005 PNAS article on "massive vegetation dieoff" (Breshears et al 2005).

Breshears' team compared the impact that two well-studied droughts had on Southern US Rockies forest mortality -- mortality, by the way, that happened even without the influence of fire.

One of the two droughts was more intense than the other. Of the two droughts, the more intense drought killed mostly older trees.

In sharp contrast, the less intense drought killed trees across age classes, and, at the time of publication, Breshears et al noted that preliminary results indicated lethal effect on trees even in wet areas.

How could the less intense of two droughts have greater lethal effect?

The researchers had other information available to them, information available to anyone: Temperature records.

When they looked at prevailing temperatures at the time of each drought, they saw that the less intense but more lethal drought had happened to coincide with a period of greater heat.

Because global average temperatures had been increasing, the Breshears team called the most lethal of the two droughts a "global change-type drought."

The forest science community worldwide noted this study with understandable interest.

If the same trend was not evident elsewhere, the massive (conifer) dieoff reported by Breshears et al in 2005 could be shrugged off, dismissed as an outlier, a freak occurrence unique to just one forested region -- the southern US Rockies - and not attributable to global increases of heat.

Similarly, the finding of forest dieoff even without fire would have to pass the test of further research, and in other forests.

Likewise, the finding that heat had lethal effect even in wet areas, would have to pass the test of further research. Only then would a coherent picture show itself.

There has been subsequent research, with effects extending all the way from low to high latitudes of North America, and well beyond.

Excerpts from that research are quoted below, in chronologic order, beginning in 2010, 5 years after PNAS published the Breshears et al findings on the impact of drought combined with heat.

As you scroll down the page, the following excerpts give you a quick overview of that further research.

"Although episodic mortality occurs in the absence of climate change, studies compiled here suggest that at least some of the world's forested ecosystems already may be responding to climate change and raise concern that forests may become increasingly vulnerable to higher background tree mortality rates and die-off in response to future warming and drought, even in environments that are not normally considered water-limited," and "Overall, our review reveals the potential for amplified tree mortality due to drought and heat in forests worldwide"(Allen et many al 2010).

"Climate-driven forest die-off from drought and heat stress has occurred around the world, is expected to increase with climate change and probably has distinct consequences from those of other forest disturbances" (Anderegg et al 2012).

"If the vapour-pressure deficit continues increasing as projected by climate models, the mean forest drought-stress by the 2050s will exceed that of the most severe droughts in the past 1,000 years. Collectively, the results foreshadow twenty-first-century changes in forest structures and compositions, with transition of forests in the southwestern United States, and perhaps water-limited forests globally, towards distributions unfamiliar to modern civilization." (Williams et al 2012).

"Warming seems already to be altering the duration and frequency of drought in some regions of the globe, a trend that will probably become clearer as global warming proceeds" (Overpeck, 2013).

"Tree mortality in relatively undisturbed old-growth forests across the West has risen even when not triggered by wildfires or insect infestations" (Funk et al, 2014).

"Although disturbances such as fire and native insects can contribute to natural dynamics of forest health, exceptional droughts, directly and in combination with other disturbance factors, are pushing some temperate forests beyond thresholds of sustainability" (Millar and Stephenson, 2015).

"Here, we reveal temporally increasing tree mortality across all study species over the last three decades in the central boreal forests of Canada, where long-term water availability has increased without apparent climate change-associated drought. ….   Our results suggest that the consequences of climate change on tree mortality are more profound than previously thought" (Luo and Chen 2015).

"Although most of the boreal forests have retained the resilience to cope with current disturbances, projected environmental changes of unprecedented speed and amplitude pose a substantial threat to their health" (Gauthier et al 2015).

"Drought and heat-induced tree mortality is accelerating in many forest biomes as a consequence of a warming climate, resulting in a threat to global forests unlike any in recorded history," and "we conclude with high certainty that today's forests are going to be subject to continued increases in mortality rates that will result in substantial reorganization of their structure and carbon storage" (McDowell and Allen, 2015).

"Estimates of megadrought probabilities based on precipitation alone tend to underestimate risk. Furthermore, business-as-usual emissions of greenhouse gases will drive regional warming and drying, regardless of large precipitation uncertainties" (Ault et al 2016).

"Warm droughts, one of the most important global climate changes, have recently occurred in North America, Africa, Europe, Amazonia, and Australia, with major effects on terrestrial ecosystems, carbon balances, and food security [1, 2]. Warm droughts can alter ecosystemic structure, composition, and services, such as carbon sequestration, biological conservation, and water regulation [3-6]. Prolonged droughts or heat can kill trees [7]. Recent studies have indicated that forest mortality induced by rising temperatures and increased drought have rapidly increased around the world during the past decade [6-9]" (Zhang et al 2017).

"Droughts of the twenty-first century are characterized by hotter temperatures, longer duration, and greater spatial extent …. This situation increases the vulnerability of ecosystems to drought, including a rise in drought-driven tree mortality globally (Allen et al. 2015) and anticipated ecosystem transformations from one state to another-for example, forest to a shrubland (Jiang et al. 2013). When a drought drives changes within ecosystems, there can be a ripple effect through human communities that depend on those ecosystems for critical goods and services (Millar and Stephenson 2015). …. Despite the high costs to both nature and people, current drought research, management, and policy perspectives often fail to evaluate how drought affects ecosystems and the "natural capital" they provide to human communities. Integrating these human and natural dimensions of drought is an essential step toward addressing the rising risk of drought in the twenty-first century."
Crausbay, et al. Defining Ecological Drought for the Twenty-First Century. Bulletin of the American Meteorological Society. December 2017.
Open Access
https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-16-0292.1

"The boreal biome represents approximately one third of the world's forested area and plays an important role in global biogeochemical and energy cycles. Numerous studies in boreal Alaska have concluded that growth of black and white spruce is declining as a result of temperature-induced drought stress. The combined evidence of declining spruce growth and changes in the fire regime that favor establishment of deciduous tree species has led some investigators to suggest the region may be transitioning from dominance by spruce to dominance by deciduous forests and/or grasslands. Although spruce growth trends have been extensively investigated, few studies have evaluated long-term radial growth trends of the dominant deciduous species (Alaska paper birch and trembling aspen) and their sensitivity to moisture availability. We used a large and spatially extensive sample of tree cores from interior Alaska to compare long-term growth trends among contrasting tree species (white and black spruce vs. birch and aspen). All species showed a growth peak in the mid-1940s, although growth following the peak varied strongly across species. Following an initial decline from the peak, growth of white spruce showed little evidence of a trend, while black spruce and birch growth showed slight growth declines from ~1970 to present. Aspen growth was much more variable than the other species and showed a steep decline from ~1970 to present. Growth of birch, black and white spruce was sensitive to moisture availability throughout most of the tree-ring chronologies, as evidenced by negative correlations with air temperature and positive correlations with precipitation. However, a positive correlation between previous July precipitation and aspen growth disappeared in recent decades, corresponding with a rise in the population of the aspen leaf miner (Phyllocnistis populiella), an herbivorous moth, which may have driven growth to a level not seen since the early 20th century. Our results provide important historical context for recent growth and raise questions regarding competitive interactions among the dominant tree species and exchanges of carbon and energy in the warming climate of interior Alaska." (Cahoon et al, 2018)

"The impact of drought on forest structure and function may be sensitive to tree size. Greater mortality of small trees may modify future forest succession whereas mortality of large trees causes disproportionate losses of carbon reserve (Phillips et al 2010, Lindenmayer et al 2012). It has not been clear whether large or small trees would suffer more under drought stress. …. In this study, we attempted to reveal the relationship between the growth of forests in the Southwest and canopy height under severe drought condition. …. Above all, our results indicated that forest resistance under severe drought might be inferred from canopy height. …. Both short and tall forests were sensitive to severe drought, but the medium-height forests had the least reduction in leaf (NDVI) and stem (RWI) growth which indicates greater resistance to severe drought. …. Another reason for the different resistance might be because medium-size trees have all the advantages of both large and small trees. Compared to the larger trees, medium-size trees have lower water demand, but compared to smaller trees, they have a more developed root system that can seek and absorb more soil water." Xu et al. Forest drought resistance distinguished by canopy height. Environmental Research Letters 2018
[Open access]<<http://iopscience.iop.org/article/10.1088/1748-9326/aacadd/meta>>

Finally, the Forest Service has made the same point, succinctly, deep in its own outlook for the impact of combined drought and heat: "In essence, a survivable drought of the past can become an intolerable drought under a warming climate" (p.50, Vose et al, 2016).
<<https://www.fs.usda.gov/treesearch/pubs/50261>>

While it's easy to agree that management actions today set the stage for what follows, what will follow from implementation of the Mid-Swan project won't necessarily match the assumptions/concepts presented in the Mid-Swan scoping document. Specifically, the project emphasizes the concept that current, familiar conifers can be maintained as a result of the proposed management actions. As you certainly know, that assumption/concept has come under growing doubt over the past several years; i.e., conifer seedlings have a hard time surviving in dry conditions (Dodson and Root 2013, Harvey et al 2016, Kueppers et al 2016, Uzra et al 2016, Welch et al 2016, Stevens-Rudmann 2018)

Even the future of established deeper-rooted, tall, old trees has been looking questionable where drought prevails; e.g., "Plants that are tall with isohydric stomatal regulation, low hydraulic conductance, and high leaf area are most likely to die from future drought stress. Thus, tall trees of old-growth forests are at the greatest risk of loss, which has ominous implications for terrestrial carbon storage." (McDowell and Allen, 2015)

Given all the above lines of evidence, there is good cause for concern that a search for "drought" in the project's scoping document resulted in only two passing, fleeting references, neither of which spells out the risks associated with drought's effect on survival of trees across age classes, and at latitudes extending from Arizona to Alaska. This, at least to me, is a significant failure in your presentation of core concept, and one that will need to be corrected as planning moves forward.

Likewise, a search for heat in the project's scoping document got only one result, and that one only a fleeting, passing reference with no reference to the effects of heat combined with drought. While a search for temperature got three results, none of the three- not even one - disclosed that rising temperatures in combination with drought pose plausible risk to the composition and structure of the Mid-Swan area. Again, this is, at least to me, is a significant failure in your presentation of core concept, and one that will need to be corrected as planning moves forward.

After all, by 2016, an article in Earth's Future reported that "… the historically hottest summers would become the norm for more than half of the world's population within 20 years."

In 2017, the Bulletin of the American Meteorological Association published findings that the record-breaking heat of 2015 "will be the new normal by 2040."

Since then, the assorted sciences gathered under the banner of climate science have reported that it will be extremely difficult to halt the heat at 2C, let alone 1.5. And in May, 2018, an article in Advances in Atmospheric Sciences cited evidence that, if the world economy continues on it's business-as-usual dependency on burning fossil fuels, we're on course to the 4C scenario.

That study was no outlier, no weird departure from the rest of reports on a future of increasing heat. In 2017, scientists describing their work were saying, "Our study indicates that if emissions follow a commonly used business-as-usual scenario, there is a 93 percent chance that global warming will exceed 4 degrees Celsius by the end of this century."

Thank you for the opportunity to comment on the concepts currently being explored for the Mid-Swan Landscape Restoration & Wildland Urban Interface Project.

Lance Olsen
624 E. Pine, C3
Missoula MT 59802
lancolsn@gmail.com