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OYSTERSHELL SCALE: AN INVASIVE THREAT TO ASPEN CONSERVATION

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Overview
Aspen decline is an acute and chronic problem in Arizona, where high levels of overstory mortality and a lack of recruitment continue to be observed. Oystershell scale (*Lepidosaphes ulmi*; OSS), an invasive sapsucking insect, has recently become widespread in native aspen stands in the southwestern U.S., further contributing to aspen mortality. Damage is severe in lower elevation stands and within ungulate exclosures created to conserve aspen. Young recruiting aspen that are rare on the landscape incur high levels of OSS-caused mortality when infested (Fig. 1). OSS has only recently become a pest of concern in the Southwest and Intermountain West, and thus, mitigation strategies are lacking for OSS in natural forest settings. OSS is also polyphagous and affects several woody hosts with thin bark, adding to management complexity. Collaborative efforts have been initiated to address OSS biology, natural predators, and management strategies.

Fig 1. *(Left) Small aspen stem infested with oystershell scale. (Right) necrotic tissue beneath infested bark, while live tissue persists on the un-infested side.*

Background

Aspen face many challenges in the western United States (U.S.), particularly in Arizona (Zegler et al. 2012). Primary drivers of aspen decline in the Southwest include a suite of abiotic and biotic factors, including climate, fire suppression, insects and diseases, and wild/domestic ungulate browsing (Fairweather et al. 2008, Zegler et al. 2012). Large decreases in aspen forests have been documented in the southwestern U.S. with Arizona experiencing some of the highest levels of mortality (USDA Forest Service 1994, Zegler et al. 2012). The greatest challenge to aspen resilience is the continued lack of recruitment to replace overstory mortality, driven largely by chronic browse pressure. Excluding ungulates from aspen regeneration sites using fencing (exclosures) has proven successful in promoting recruitment in localized areas. However, an invasive insect, OSS is especially pervasive in densely stocked exclosures and impacts natural stands, contributing to severe dieback and mortality (Crouch et al. 2021). OSS has become a serious threat to aspen across northern Arizona (Fig.2) with reports of severe infestations and aspen mortality in natural stands from Utah, Nevada, Nebraska, and South Dakota (See **Sources**). There is an urgent need to fill critical knowledge gaps related to regionally specific biology of the insect and to develop novel management techniques to mitigate impacts of infestations.

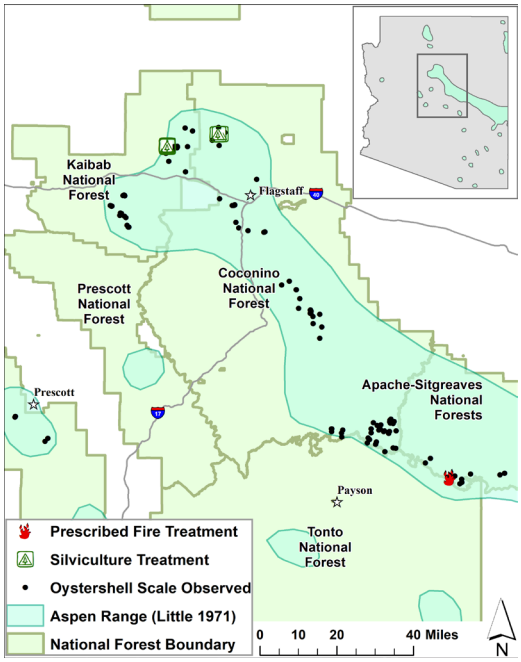

Fig 2. *Extent of oystershell scale and experimental treatment locations in northern Arizona. (Map by Isaac Dell)*

Experimental Treatments and Preliminary Results

There are no scientifically proven strategies for managing OSS in natural forest settings. Research and development of such strategies are an immediate priority, and experimental work is underway in Arizona to understand how silvicultural treatments and prescribed fire influence OSS outbreaks at the stand-level. OSS is an obligate parasite and relies on a living host to complete its life cycle, making host tree removal a potentially viable management option. Importantly, aspen

regenerates prolifically after both clearfelling and fire, so these treatments have the potential to not only reduce OSS infestation levels but also to regenerate aspen; however, effective ungulate browse management must be coupled with any such strategies to ensure adequate recruitment.

Sanitation treatments remove trees from a stand to try and reduce stand-level OSS populations. *Clearfelling* removes all trees, thus killing all infested trees on a site. This is more practical where aspen stands tend to be small and dispersed across the landscape, compared to areas where aspen occupy broad swaths of the landscape. *Thinning* removes only infested trees, leaving un-infested trees behind, and may be effective by increasing residual tree vigor or defenses, reducing environmental favorability for OSS, or both and is more aesthetically appealing than clearfelling. Preliminary results from clearfell experiments on two different sites in northern Arizona (Fig. 2 & 3) indicate that aspen regeneration remains OSS-free through two years of monitoring after clearfelling. Importantly, aspen logs that were heavily infested with OSS and placed on burn piles after cutting did not cause infestation of aspen suckers that grew adjacent to the piles. A major limitation of silvicultural OSS management is that clearfelling or thinning aspen will not address OSS infestations in aspen or other host species that may occur in the understory.

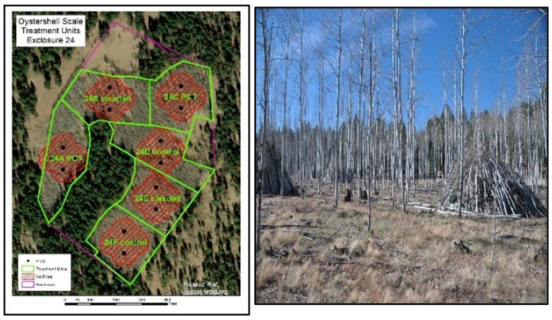

Fig 3. *(Left) Treatment design. (Right) Implementation of a sanitation thinning at one site on the Coconino National Forest.*

Prescribed fire may be a more effective strategy for managing OSS on sites with infested understory hosts or regeneration. Fire could directly kill OSS or indirectly kill it by killing host trees and shrubs. Preliminary results after a high-severity prescribed fire in northern Arizona (Fig. 2) indicate aspen suckers were OSS-free in the first year after fire, but three suckers (1.4% of total) developed trace infestations of OSS in year two. A potentially important limitation of prescribed fire for OSS management is that fire is patchy, especially in aspen stands that can be difficult to burn, so not all OSS in a stand is certain to be removed.

Systemic insecticides may provide important intermittent treatments following overstory removal and where infested understory hosts or regeneration occur. Systemic insecticides, with multiple application methods may be most useful for stand level treatments in natural settings which are highly diverse. Dinotefuran® is currently recommended for OSS management in urban settings and products containing this active ingredient are labeled for use in forest settings as targeted applications to the soil, bark, or leaves of infested aspen (Cranshaw 2013). Pesticide applications are important tools for Integrated Pest Management (IPM) programs, and control in urban areas; however, efficacy and impacts to non-target resources are important topics that need further vetting prior to broad treatment recommendations.

Key Findings:

- OSS is widespread in Arizona and outbreaks have been documented in Utah, Nevada, Nebraska, and South Dakota
- OSS is limited to lower elevation < 8,366 ft (< 2,550 m) aspen in northern Arizona
- OSS is particularly pervasive in densely stocked ungulate exclosures and damaging to younger, recruiting stems
- OSS affects a wide array of woody plant hosts with thin bark, including understory and several riparian species

What's needed?

1. Continue high prioritization of research and development of OSS basic biology and management strategies.
2. Increased monitoring to understand where OSS is present in urban areas and natural aspen forests throughout the western U.S.
3. Long-term support for monitoring infestations, including permanent plot re-measurements.
4. Citizen Science: download the ArcGIS Survey123 app and use this QR code to download our public accessible OSS survey form to report suspected OSS in the U.S. Complete all questions and include photographs.

Sources

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