

Research Efforts to Curb Balsam Woolly Adelgid

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True firs are important high-elevation trees that are threatened by numerous stressors. Adding to the list of stressors is the balsam woolly adelgid, a small plant-feeding insect that was discovered in northern Utah in 2017. USU research is investigating the adelgid life cycle, host susceptibility, and site factors to predict outbreaks.

Balsam woolly adelgid (BWA) has been a pest of eastern North American firs for over a century, initially found attacking balsam fir in eastern Canada and Maine. Native to southern and central Europe, it is believed to have been introduced on nursery stock. By 1960, populations were established along the east and west coast regions of the U.S. and Canada, likely from independent introductions from Europe. During the adelgid's initial spread in the 1960s and 70s in the Appalachian Mountains, Fraser fir populations declined by 80%. BWA are found on bark, feeding on plant cells (parenchyma) of all members of the *Abies* genus including balsam fir, Fraser fir, grand fir, white fir, and subalpine fir (its primary host in Utah), with differing levels of intensity. The ubiquity of fir in mountainous areas of the Intermountain West may allow for continued spread of BWA. True firs are important sources of food and shelter for high-elevation wildlife, and in mixed stands, they provide diversity in the event of pine or spruce beetle outbreaks.

Identifications and Symptoms: In its native European range, BWA has a complex life cycle alternating between spruce and fir host trees, causing very little damage to these trees due to their long evolutionary relationship. In

North America, only asexual reproduction occurs, and tree damage has been severe. In the heaviest of infestations, matrices of white, woolly masses of adelgids occur along the tree bark, branches, and twigs. Toxins in the adelgids' saliva cause swellings (also known as gouting) along the nodes of young branches. Extended feeding leads to dieback and flagging of branches, and tree death may occur within five years of initial infestation. Asexual reproduction creates BWA offspring that are nearly genetic clones of the parent, increasing the likelihood of pesticide or environmental resistance that can be passed on to the next generation.

Evidence suggests that fir species have differing levels of resistance, and a better understanding of this is needed as BWA continues to colonize white and subalpine fir in Utah. In addition, BWA is difficult to detect during early establishment, and rates of establishment can vary. Learning its adaptability to gradients of climatic conditions is essential.

Research at Utah State University

With funding from USDA Forest Research and Development, researchers at Utah State University and the US Forest Service-Rocky Mountain Research Station are conducting several studies in the Intermountain West, including:

- **Improving understanding of BWA's seasonal phenology (development) on subalpine fir:** We are sampling stands in northern Utah with a range of elevation and site characteristics for BWA presence and intensity. We will collect bark samples to count and identify adelgid life stages.
- **Providing predictions for risk of spread and establishment:** We will lab-rear BWA at USU to identify the minimum temperature at which development begins. From this, we will generate a model to use in combination with local climate data to provide insights to timely management of BWA in Utah's subalpine fir forests.
- **Developing a rating system that can be used by stakeholders to assess the risk of BWA in their stands:** Through an interagency effort, we have identified sites across northern and central Utah and southern Idaho where BWA and associated damage are present. For each stand, we will collect assessment data such as composition of tree species, sizes, ages, and health, elevation, and soil type. On individual fir trees within each stand, we will also record BWA symptoms such as crown flagging, extent of dieback and gouting, and level of bole infestation. Stand characteristics that appear

to contribute to susceptibility, spread, and damage will be identified and quantified. Individual variables included in the rating system may be used to identify areas of concern within stands (such as structure or average size) and guide preventive or responsive treatments to balsam woolly adelgid.

Die-off in fir stands contributes to ecosystem decline including increased erosion, loss of forage and habitat for wildlife, and declines in watershed quality and forest resilience. Losses may also affect tourism, in particular, in Utah's ski industry where subalpine fir is common along ski slopes. Stakeholders in various organizations such as the USDA, the US Forest Service, and USU are coordinating efforts to monitor and study BWA's potential spread and impact in Utah. Our study results will help support forest management agencies and landowners in timely and specific management practices based on site characteristics.

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