

## RESEARCH NOTE

# Post-wildfire response of Shasta snow-wreath

LEN LINDSTRAND III<sup>1\*</sup>, JULIE A. KIERSTEAD<sup>2</sup>, AND DEAN W. TAYLOR<sup>3†</sup>

<sup>1</sup>Sierra Pacific Industries, P.O. Box 496014, Redding, CA 96049-6014, USA

<sup>2</sup>P. O. Box 491536, Redding CA, 96049, USA

<sup>3</sup>3212 Redwood Drive, Aptos, CA, 95003, USA

<sup>†</sup>Deceased

\*Corresponding Author: [llindstrand@spi-ind.com](mailto:llindstrand@spi-ind.com)

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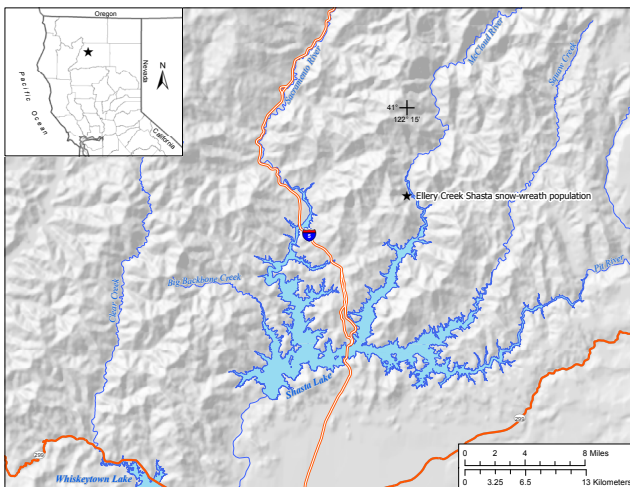
Shasta snow-wreath (*Neviusia cliftonii*) is a rare shrub of the Rosaceae: tribe Kerrieae endemic to the southeastern Klamath Mountains in the general vicinity of Shasta Lake, Shasta County, California. The species was discovered less than 30 years ago (Shevock et al. 1992; Taylor 1993) and initially considered a limestone obligate. Subsequent occurrences have also been found on various non-limestone substrates (Lindstrand and Nelson 2005a, b, 2006; DeWoody et al. 2012; Jules et al. 2017). The only congener, Alabama snow-wreath (*Neviusia alabamensis*), also has a limited range restricted to several disjunct populations in the southeastern United States and occurs on limestone and non-limestone sedimentary substrates (Long 1989; Freiley 1994).

Shasta snow-wreath is deciduous and produces flowers with showy white stamens, five toothed green sepals, and rarely, one to three narrow white petals. Based on our observations since its discovery, the species reproduces vegetatively, forming thickets of stems from the root system. Despite observations of developing achenes, no viable seed nor seedlings have been collected or observed. We are not aware of any pollinators and the blooms lack detectable scent. Genetic sampling at 21 Shasta snow-wreath populations conducted during 2011 revealed low genetic diversity within populations, high variation between populations, and low overall genetic diversity, supporting the theory that sexual reproduction is less common than vegetative reproduction and that there is, at best, low gene flow within and between populations (DeWoody et al. 2012). Alabama snow-wreath is also only known to reproduce vegetatively, in the wild (Freiley 1994).

Shasta snow-wreath currently holds a California Rare Plant Rank of 1B.2 (CDFW 2020) and also is considered a Sensitive species by the Region 5 U.S. Department of Agriculture Forest Service and the California Region of U.S. Department of Interior Bureau of Land Management. Recent petitions have been submitted to the U.S. Fish and Wildlife Service and California Fish and Game Commission seeking species protection under the Federal Endangered Species Act and California Endangered Species Act, respectively (CFGC 2019; Roche 2019; USFWS 2019).

Little is known about the species response to natural disturbances or land management activities. Based on our observations, four populations occur in habitat subject to historic logging; and a hiking trail, which receives occasional maintenance, was constructed through another. Shasta snow-wreath plants along the trail were also grubbed or cut for a prescribed burn in the 1990s and plants resprouted in the disturbed area. Several shrubs occupying a limited portion of a small population at another location were burned during a low-intensity prescribed fire in 2011, and these plants also showed vegetative resprouting. Additionally, two populations were disturbed by historic dirt road construction and Shasta snow-wreath plants have since reoccupied some of the former road surfaces. The Klamath Mountains historically experienced frequent wildfires (Taylor and Skinner 2003; Fry and Stephens 2006; Safford and Van de Water 2014), including within the species range, and burn scars occur on trees among several Shasta snow-wreath populations. While existing in a historically fire-prone landscape, no known Shasta snow-wreath populations had been subject to wildfire since its 1992 discovery, until 2018.

Several large wildfires occurred in Shasta County, California, during 2018, including the Hirz Fire. This human-caused fire started 9 August and was contained 15 September 2018. The fire footprint encompassed approximately 18,676 ha and included a burned and unburned mosaic, with burn areas characterized by low, medium, and high burn severity classes as classified using Parsons et al. (2010), depending on location. Two known Shasta snow-wreath populations occur in the Hirz Fire footprint; one located near the Ellery Creek confluence with the McCloud River Arm of Shasta Lake (40.9148, -122.2473) (Figure 1), and a second located in an unnamed creek drainage approximately 0.59 km south of Ellery Creek. The fire burned portions of the “south of Ellery Creek” population and the entire Ellery Creek population, providing opportunity to observe post-wildfire response of Shasta snow-wreath at a large scale. We determined the Ellery Creek population best suited for post-wildfire monitoring and planned a monitoring effort at the site.



**Figure 1.** General location map, Ellery Creek Shasta snow-wreath population, Shasta County, California, USA.

The Ellery Creek Shasta snow-wreath population encompasses approximately 11.5 ha and occurs on a northerly aspect slope in a steep canyon characterized by numerous limestone outcroppings. Overall habitats are dominated by hardwood-conifer forest with chaparral inclusions surrounding the limestone outcroppings. The Ellery Creek population occurs in three habitats: hardwood-conifer forest dominated by Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), canyon live oak (*Quercus chrysolepis*) and California black oak (*Quercus kelloggii*); hardwood forest dominated by California black oak; and chaparral habitat dominated by Brewer oak (*Quercus garryana* var. *breweri*).

We initiated post-fire monitoring at the Ellery Creek Shasta snow-wreath population during October 2018 by conducting a site visit to determine the extent of fire damage and overall condition of the population. During the visit we established an informal transect used to conduct monitoring observations. We designed the transect to meander through the entire population, including all three habitats and elevational gradient, and generally walked the same transect during each visit. The entire Ellery Creek population burned in the fire, with moderate and high burn severity classes (Figure 2). Most of the Shasta snow-wreath population occurring in the hardwood-conifer forest habitat burned at moderate severity, while those portions occurring in the hardwood and chaparral habitats burned at high severity. The fire top-killed all above ground Shasta snow-wreath stems, most of which burned to the ground leaving small root crowns, or charred skeletons remaining. Examination of the below ground stem segments suggested they remained viable, as the stems appeared “green” and otherwise normal, including at high severity burn areas. During the October visit, we



**Figure 2.** Portion of the Ellery Creek Shasta snow-wreath population during October 2018 burned in the 2018 Hirz Fire, Shasta County, California, USA. Photo by Len Lindstrand III.

observed numerous associated species crown-sprouting shortly following the fire, including big-leaf maple (*Acer macrophyllum*), California black oak, Brewer oak, canyon live oak, California snowdrop bush (*Styrax redivivus*), western redbud (*Cercis occidentalis*), deer brush (*Ceanothus integerrimus*), poison oak (*Toxicodendron diversilobum*), mock orange (*Philadelphus lewisii*), spicebush (*Calycanthus occidentalis*) and hazelnut (*Corylus cornuta*). However, we did not observe resprouting Shasta snow-wreath at that time.

Following the initial assessment, we conducted monthly site visits from March through July and October 2019. During each visit we made observations of Shasta snow-wreath response to the fire, including presence or absence of vegetative sprouting, seedlings, plant health and vigor, and other ecological factors such as sign of herbivory and associated species.

We observed resprouting Shasta snow-wreath at the beginning of the first growing season following the fire on a site visit conducted 30 March 2019. The newly emerged growth ranged from 0.6 and 1.9 cm tall and was observed throughout the population sprouting from woody rhizomes and burned root crowns (Figures 3, 4). We observed continual vigorous and dense resprouting from April through July (Figure 5), with the new growth reaching 0.9 m tall. The October 2019 visit showed the new growth reaching 1.1 m tall (Figure 6), likely the upper height limit for the 2019 growing season. By this time several rain events



**Figure 3.** Shasta snow-wreath resprouting from burned root crown during March 2019, Ellery Creek, Shasta County, California, USA. Photo by Len Lindstrand III.



**Figure 4.** Shasta snow-wreath resprouting from woody rhizome during March 2019, Ellery Creek, Shasta County, California, USA. Photo by Len Lindstrand III.

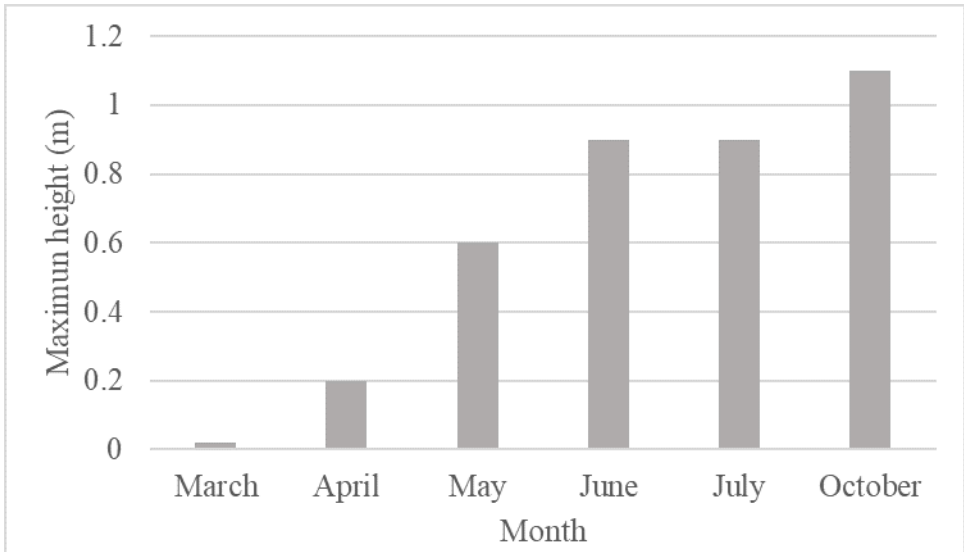


**Figure 5.** Dense Shasta snow-wreath resprouting during October 2019 following the 2018 Hirz Fire, Ellery Creek, Shasta County, California, USA. Photo by Len Lindstrand III.

had occurred and cooler fall temperatures arrived. Many of the Shasta snow-wreath plants showed new leaf growth and some additional new rhizome and root crown sprouting. New leaf growth during the fall is a regular response of “normal” Shasta snow-wreath populations and many other local shrub species, suggesting this resprouting population is following a typical growth pattern.

The Ellery Creek Shasta snow-wreath population is extant and in good overall condition. The resprouted plants did not flower during 2019, and monitoring will be continued to determine the duration until the shrubs bloom again. We observed occasional deer (*Odocoileus hemionus*) browsing among the re-sprouting Shasta snow-wreath; however, the browsing appeared limited to those plants located on and adjacent to game trails, and not throughout the entire population. No evidence of plant disease was observed.

The 2019 post-wildfire monitoring observations confirmed our belief that Shasta snow-wreath responds well to wildfire by vegetative reproduction. We speculated that Shasta snow-wreath seed might have been stimulated by this fire event and that seedlings would appear; however, none were observed during our monitoring. Our confirmation of reproduction exclusively by resprouting is consistent with known genetic relationships within and among Shasta snow-wreath populations (i.e., DeWoody et al. 2012) and is consistent with previous observations regarding seedling observations and seed viability. Considering wildfire is by far the most common historical and current natural disturbance within the species range, our observations suggest that Shasta snow-wreath reproduction may be restricted to only vegetative reproduction.



**Figure 6.** Shasta snow-wreath resprouting stem heights during 2019 following the 2018 Hirz Fire, Ellery Creek, Shasta County, California, USA.

**Authors Note:** During a site visit to Ellery Creek on 28 April 2020, the first Author documented portions of the Shasta snow-wreath population in flower, demonstrating the species is capable of flowering two years post-fire. Several of the flowers observed included a single petal, a rare species trait, as most flowers and populations are typically apetalous.

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#### Author Contributions

Conceived and designed the study: LL

Collected the data: LL, JK

Performed analyses of the data: LL, JK, DWT

Authored the manuscript: LL

Provided critical revision of the manuscript: JK, DWT

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