State of California
Natural Resources Agency
Department of Fish and Wildlife

REPORT TO THE FISH AND GAME COMMISSION
STATUS REVIEW OF SHASTA SNOW-WREATH (*Neviusia cliftonii*)

November 2021

Shasta snow-wreath (*Neviusia cliftonii*), CDFW photo by Cherilyn Burton

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TABLE OF CONTENTS

LIST OF FIGURES iii
LIST OF TABLES iii
LIST OF APPENDICES iii
LIST OF ABBREVIATIONS, ACRONYMS AND TERMS iv
EXECUTIVE SUMMARY v
INTRODUCTION 1
Petition History 1
Status Review 2
Notification, Information Received, and Peer Review 3
BIOLOGY 3
Species Description 3
Taxonomy 4
Range and Distribution 6
Life History 8
Genetics 9
Similar-looking Plants 12
Habitat that may be Essential to the Continued Existence of the Species 12
Vegetation Communities 14
Geology and Soils 16
Climate, Hydrology, and other factors 16
ABUNDANCE AND POPULATION TRENDS 18
FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE 19
Genetics, Reproductive Challenges, and Restricted Range 19
Habitat Modification and Destruction 21
Invasive Species 26
Climate Change 29
Altered Fire Regimes 31
REGULATORY AND LISTING STATUS 32
Federal 32
State 33

Natural Heritage Program Ranking 33
California Rare Plant Rank 34
EXISTING MANAGEMENT EFFORTS 34
National Forest Service Lands 34
Monitoring 35
SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF SHASTA SNOW-WREATH IN CALIFORNIA 36
Present or Threatened Modification or Destruction of Habitat 36
Overexploitation 37
Predation 37
Competition 37
Disease 38
Other Natural Occurrences or Human-related Activities 38
SUMMARY OF KEY FINDINGS 39
RECOMMENDATION FOR PETITIONED ACTION 40
PROTECTION AFFORDED BY LISTING 41
MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES 42
ACKNOWLEDGEMENTS 43
LITERATURE CITED 43
Literature 43
Personal Communication 56

LIST OF FIGURES

Figure 1. Photographs of Shasta Snow-wreath (*Neviusia cliftonii*) 5
Figure 2. Distribution of Shasta Snow-wreath Populations 7
Figure 3. Land Ownership of Shasta Snow-wreath Populations 8
Figure 4. Relationship of Ramets to Genets 10
Figure 5. Shasta Snow-wreath and Similar Looking Species 13
Figure 6. Shasta Snow-wreath Habitat 15
Figure 7. Shasta Snow-wreath Population at Waters Gulch 27
Figure 8. Invasive Species. 28

LIST OF TABLES

Table 1. Status Review Peer Reviewers 3
Table 2. Number of Genets Compared to Ramets at Shasta Snow-wreath Populations Sampled in DeWoody et al. (2012). 11
Table 3. Direct Impacts to Shasta Snow-wreath Populations from the Proposed Project to Raise Shasta Dam 23

LIST OF APPENDICES

APPENDIX A. Summary of Shasta Snow-wreath Populations and Threats
APPENDIX B. Comments from Affected and Interested Parties on the Petitioned Action
APPENDIX C. External Peer Review Invitation Letters and Comments from Peer Reviewers on the Shasta Snow-wreath Status Review Report

LIST OF ABBREVIATIONS, ACRONYMS AND TERMS

CEQA – California Environmental Quality Act

CESA – California Endangered Species Act

CNDDB – California Natural Diversity Database

CNPS – California Native Plant Society

Commission – California Fish and Game Commission

CRPR – California Rare Plant Rank

Department – California Department of Fish and Wildlife

Occurrence – CNDDB Element Occurrence

Evaluation – Evaluation of a Petition from Kathleen Roche to List Shasta Snow-Wreath as Endangered under the California Endangered Species Act

Id. – "the same"

NEPA – National Environmental Policy Act

Petition - Petition to the State of California Fish and Game Commission to List the Shasta Snow-wreath (*Neviusia cliftonii*) as Endangered under the California Endangered Species Act, dated September 30, 2019

SPI – Sierra Pacific Industries

Status Review – Status Review of Shasta Snow-wreath (*Neviusia cliftonii*)

subsp. – Subspecies

var. – Variety

EXECUTIVE SUMMARY

This Status Review of Shasta Snow-wreath (*Neviusia cliftonii*) (Status Review) has been prepared by the California Department of Fish and Wildlife (Department) for the California Fish and Game Commission (Commission) pursuant to the requirements of the California Endangered Species Act (CESA). This Status Review has been independently reviewed by scientific peers and is based upon the best scientific information available to the Department.

Shasta snow-wreath is a deciduous shrub in the rose family (Rosaceae) that was first discovered in 1992. Shasta snow-wreath is known from 26 California Natural Diversity Database element occurrences (element occurrences) in the eastern Klamath Ranges in Shasta County, California, near Shasta Lake. Shasta snow-wreath grows primarily in riparian areas in the dense understory of shady montane hardwood-conifer and ponderosa pine forests, and is also found in foothill pine-blue oak woodland habitat. Shasta snow-wreath populations occur on limestone and a variety of substrates derived from metamorphic and igneous rocks, such as shale, mudstone, and greenstone.

Little information is available on Shasta snow-wreath population trends, but it is presumed that populations were larger and more connected prior to the construction of Shasta Dam and the filling of Shasta Lake in the 1940s. Shasta snow-wreath is threatened by competition with aggressive invasive plant species such as Himalayan blackberry, French broom, and Scotch broom. Shasta snow-wreath is also limited in its ability to reproduce, since it appears to be restricted to vegetative reproduction and no seedlings of this species have been observed. Shasta snow-wreath has very low genetic diversity within populations, which is typical of species that reproduce by vegetative means, and populations seemingly comprised of hundreds to thousands of plants could actually be comprised of clones of only a few genetically distinct individuals. Populations with low genetic diversity are vulnerable to extirpation due to changing environmental conditions and stochastic (chance) events.

Populations of Shasta snow-wreath are also threatened by the proposed project to raise the height of Shasta Dam, which would raise the water level of Shasta Lake by 6.25 m (20.5 ft), resulting in impacts to portions of half of the known element occurrences. Shasta snow-wreath may also be affected by climate change, compounding the risk of extirpation faced by populations with low genetic diversity. Shasta snow-wreath is considered a relict species, or a “living fossil” remaining from a formerly more widespread group whose close relatives have gone extinct, and the species may also face a phenomenon called extinction debt. Extinction debt refers to the future extinction of a species due to past disturbances from which it cannot recover. It can take a considerable amount of time for a population or species to disappear following disturbances such as habitat loss or degradation.

The information available to the Department regarding the status of Shasta snow-wreath indicates that there are significant threats to the continued existence of the species. In addition to evaluating whether the petitioned action to list the species as endangered is warranted, the Department also considered whether listing as threatened under CESA is warranted. Based on review of the best available scientific information, the Department finds that Shasta snow-wreath, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by CESA. The Department recommends that listing Shasta snow-wreath as threatened under CESA is warranted at this time.

INTRODUCTION

This Status Review addresses Shasta snow-wreath (*Neviusia cliftonii* Shevock, Ertter & D.W. Taylor).

Petition History

On September 30, 2019, the Fish and Game Commission (Commission) received a petition (Petition) from Ms. Kathleen Roche to list Shasta snow-wreath as an endangered species pursuant to the California Endangered Species Act (CESA; Fish & G. Code, § 2050 *et seq*.).

On October 10, 2019, the Commission referred the Petition to the California Department of Fish and Wildlife (Department) for evaluation.

On November 6, 2019, pursuant to Fish and Game Code section 2073.5, the Department requested a 30-day extension of time to complete its evaluation report.

On November 22, 2019, as required by Fish and Game Code section 2073.3, the Commission published notice of receipt of the Petition in the California Regulatory Notice Register. (Cal. Reg. Notice Register 2019, No. 47-Z, p.1592, https://oal.ca.gov/wp-content/uploads/sites/166/2019/11/2019-Notice-Register-Number-47-Z-November-22-2019.pdf).

On February 3, 2020, the Department provided the Commission with a report, "Evaluation of a Petition from Kathleen Roche to List Shasta Snow-Wreath as Endangered Under the California Endangered Species Act" (Evaluation). Based upon the information contained in the Petition, the Department concluded, pursuant to Fish and Game Code section 2073.5(a), that sufficient information exists to indicate that the petitioned action may be warranted and recommended to the Commission that the Petition should be accepted and considered.

On April 16, 2020, at its scheduled public meeting via teleconference, the Commission considered the Petition, the Department's Evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for consideration.

Subsequently, on May 1, 2020, the Commission published its Notice of Findings for Shasta snow-wreath in the California Regulatory Notice Register, designating Shasta snow-wreath as a candidate species. (Cal. Reg. Notice Register 2020, No. 18-Z, p. 692, https://oal.ca.gov/wp-content/uploads/sites/166/2020/05/2020-Notice-Register-Number-18-Z-May-1-2020.pdf).

The Department promptly commenced its review of the status of the species as required by Fish and Game Code section 2074.6. On April 14, 2021, the Commission approved the Department's request for a six-month extension to facilitate external peer review and complete the status review, which has now concluded with this Status Review document.

Status Review

Pursuant to Fish and Game Code section 2074.6 and California Code of Regulations, title 14, section 670.1, the Department has prepared this Status Review to indicate whether the petitioned action to list Shasta snow-wreath under CESA is warranted. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species is one that "although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [CESA]" (*Id.*, § 2067).

Using the best scientific information available to the Department, this Status Review includes information on each of the following components pursuant to Fish and Game Code section 2072.3 and California Code of Regulations, title 14, section 670.1: population trend(s); range; distribution; abundance; life history; factors affecting the species' ability to survive and reproduce; the degree and immediacy of threats; the impact of existing management efforts; the availability and sources of information; habitat that may be essential for the continued existence of the species; and the Department's recommendations for future management activities and other recovery measures to conserve, protect, and enhance the species.

Specifically, this Status Review analyzes the best available science in order to recommend whether the continued existence of Shasta snow-wreath throughout all or a significant portion of its range is in serious danger or is threatened by one or a combination of the following factors: present or threatened modification or destruction of its habitat; overexploitation; predation; competition; disease; or other natural occurrences or human-related activities. (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A).).

This Status Review was prepared by Cherilyn Burton in the Department's Habitat Conservation Planning Branch, Native Plant Program.

Notification, Information Received, and Peer Review

Following the Commission's action to designate Shasta snow-wreath as a candidate species, the Department notified affected and interested parties and solicited data and comments on the petitioned action pursuant to Fish and Game Code section 2074.4 (see also Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)). Comments on the petitioned action were invited via a general notification dated July 7, 2020, and a tribal notification dated July 14, 2020. These notifications were distributed to tribes, owners and managers of lands supporting Shasta snow-wreath populations, and other interested individuals and organizations. The Department received one comment in response to the general notification and one e-mail in response to the tribal notification. All responses received are included in Appendix B to this report.

Pursuant to Fish and Game Code section 2074.6, the review process included independent peer review of the draft status review by persons in the scientific and academic community acknowledged to be experts on Shasta snow-wreath and possessing the knowledge and expertise to critique the scientific validity of the Status Review. Appendix C contains the specific input provided to the Department by the individual peer reviewers, the Department's written response to the input, and any amendments made to the draft Status Review report (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)). Independent experts that reviewed the Status Review are listed in Table 1, below.

Table 1. Status Review Peer Reviewers

Name	Title and Affiliation
Julie Kierstead	Forest Botanist 1989-2019 (retired), Shasta-Trinity National Forest
Len Lindstrand III	Botany Manager, Sierra Pacific Industries
Jane Van Susteren	Regulations Coordinator/Senior Environmental Scientist, Board of Forestry and Fire Protection

BIOLOGY

Species Description

Shasta snow-wreath is a deciduous understory shrub that grows to a height of approximately 2.5 m (8.2 ft) (Shevock et al. 1992). It has erect, slender branches that are rarely greater than 1 cm (0.4 in) in diameter. The bark of Shasta snow-wreath is grayish near the base of the plant and reddish brown above, exfoliating in strips (Shevock et al. 1992). Its oval to heart-shaped, coarsely-toothed, bright green leaves are arranged alternately along the slender stems and are sparsely covered with stiff, straight, appressed hairs that are approximately 0.4 mm (0.02 in) long (Shevock et al. 1992; Heikens and Ertter 2012). The inflorescence of Shasta snow-wreath is generally

comprised of three to five flowers arranged in an umbel-like cluster, meaning each pedicel (i.e., flower stalk) seemingly radiates from a common point of attachment without an evident axis or branches. The pedicels are 1-3 cm (0.4-1.2 in) long and are very slender (approximately 0.3 mm wide). Shasta snow-wreath flowers are bisexual, which means they contain both male and female organs in the same flower. Each flower has approximately 50 showy white stamens (male reproductive structures) that are each about 4-5 mm (0.2 in) long, and 2 to 6 pistils (female reproductive structures), each with an ovary that is densely covered in white stiff, straight, appressed hairs. There are sometimes one, two, or rarely three white petals present on the flowers that are 4-6 mm (0.2 in) long, but the petals are usually absent (Shevock et al. 1992) (Figure 1). Shasta snow-wreath flowers have 5 to 6 oval sepals that are 4-6 mm (0.2 in) long and are irregularly few-toothed (Shevock et al. 1992; Heikens and Ertter 2012). The fruit is an achene, which is a dry, indehiscent (not splitting open), one-seeded fruit from a one-chambered ovary in which the fruit wall is free from the seed.

Taxonomy

Shasta snow-wreath was first discovered and described in 1992 and was added to the genus *Neviusia*, which contains one other extant species, Alabama snow-wreath (*Neviusia alabamensis* A. Gray) (Shevock et al. 1992; Taylor 1993; Heikens and Ertter 2012). The genus *Neviusia* is in the rose family (Rosaceae), which is a large family containing 110 genera and approximately 3000 species worldwide (Potter and Ertter 2014). *Neviusia* is in the Kerrieae tribe of the rose family, which consists of *Neviusia* and three other genera (*Coleogyne*, *Kerria*, and *Rhodotypos*) that each are comprised of just one species (Brouillet 1993; Potter et al. 2007). The four genera are highly distinct morphologically and are regarded as ancient relicts (Brouillet 1993; Stebbins 1993; Potter et al. 2007). A relict is a species or a group of species remaining from a large group that is predominantly extinct (Grandcolas et al. 2014). Relict species, such as Shasta snow-wreath, are of high value for conservation biology because they are the only surviving representatives of a formerly more widespread group whose close relatives have gone extinct, and they are often regarded as “living fossils” or remnants of old times (Grandcolas et al. 2014).

Alabama snow-wreath occurs in several disjunct populations in the southeastern United States and is considered rare throughout its highly restricted range (Long 1989; NatureServe 2020). Both species of *Neviusia* are considered relict species descended from a formerly widespread genus, and fossil evidence from Southern British Columbia supports the ancient origin of the genus (DeVore et al. 2004).

(a)

(b)

Figure 1. Photographs of Shasta snow-wreath (*Neviusia cliftonii*). (a) Shasta snow-wreath thicket of many stems (ramets). (b) Shasta snow-wreath flowers.

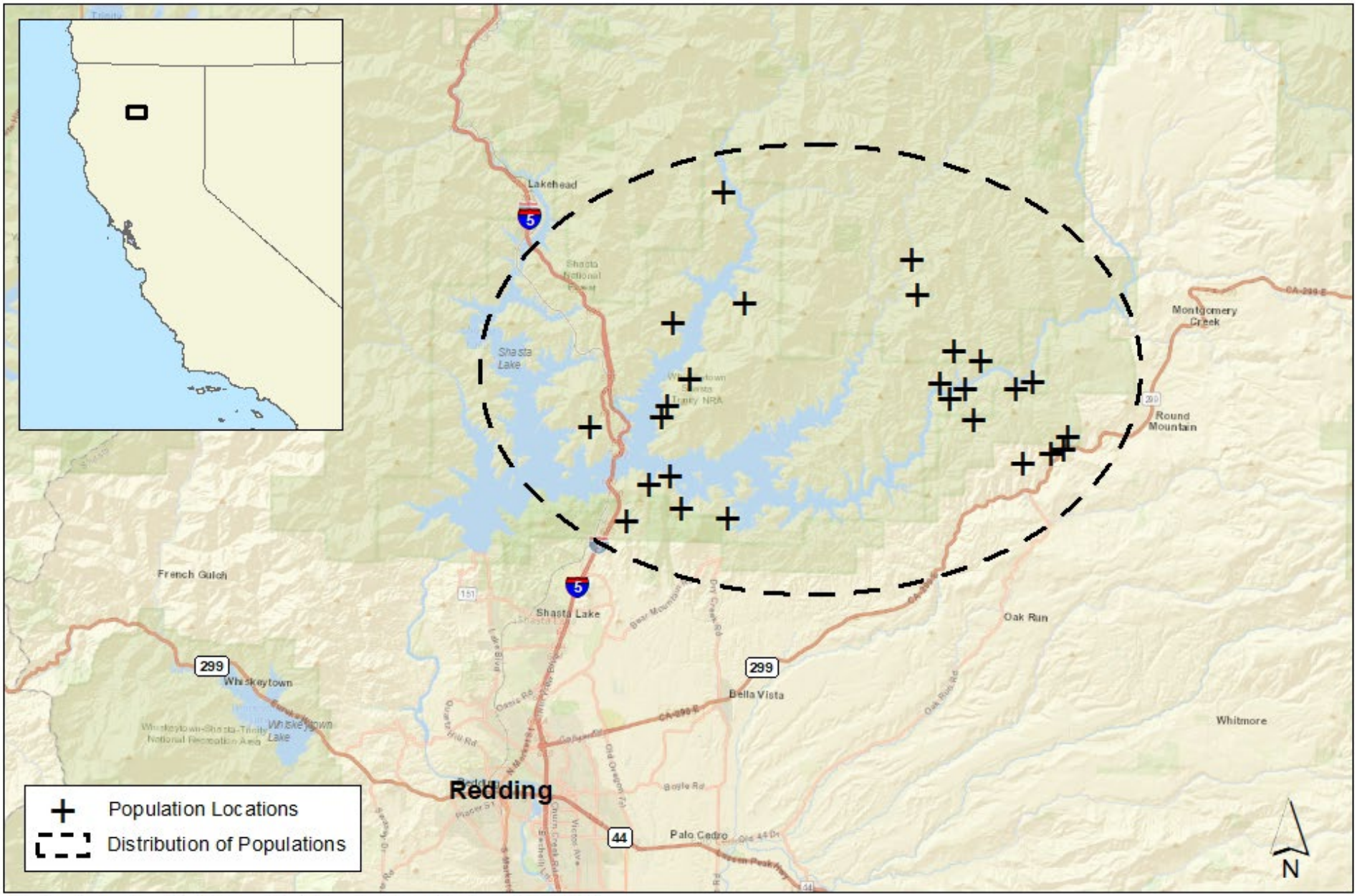
Range and Distribution

Range is the general geographical area where an organism occurs. For purposes of CESA and this Status Review, the range of a species is strictly its California range (*Cal. Forestry Assn. v. Cal. Fish and Game Com*. (2007) 156 Cal.App.4th 1535, 1551). Distribution refers to actual sites where individuals and populations of the species occur within the species' range.

Shasta snow-wreath occurs only in California in the eastern Klamath Ranges in Shasta County at elevations from 328 to 540 meters (1075 to 1772 feet) (CNDDB 2021). The total range covers approximately 650 square kilometers (250 square miles) (NatureServe 2020). All known populations of Shasta snow-wreath are in the vicinity of Shasta Lake, north of the city of Redding (Figure 2) (CNDDB 2021), and are found within the Cow Creek, McCloud River, Pit River, Sacramento River, and Squaw Creek watersheds (Jules et al. 2017).

As mentioned above in the Taxonomy section, Shasta snow-wreath is considered a relict species descended from a formerly widespread genus (Shevock et al. 1992; Ertter 1993; DeVore et al. 2004, 2005). Relict species arise when much of a widespread population becomes extinct, leaving behind small, isolated patches. The remaining patches of the population evolve in isolation into distinct species with unique characters (DeVore et al. 2005). Fossil evidence of a closely related plant species that is now extinct (*Neviusia dunthornei* DeVore, Moore, Pigg & Wehr) from the Pacific Northwest Eocene flora (56 to 33.9 million years ago) suggests that Shasta snow-wreath's range may have once extended as far north as British Columbia, Canada (DeVore et al. 2004, 2005; DeVore and Pigg 2007).

The current distribution of Shasta snow-wreath is documented in the California Natural Diversity Database (CNDDB). The CNDDB documents plant taxa, animal taxa, and natural communities that are of conservation concern within California and refers to these taxa as "elements." An "element occurrence" is a location record for a site which contains an individual, population, nest site, den, or stand of a special status element. Populations, individuals, or colonies that are located within 0.4 km (0.25 mi) of each other generally constitute a single element occurrence, sometimes with multiple "parts" (Bittman 2001). In some instances, parts of a single element occurrence could be separated by topography or other landscape and habitat characteristics, but regardless of the circumstances, all parts or populations that are within 0.4 km (0.25 mi) of each other are grouped into the same element occurrence in the CNDDB. The CNDDB records for Shasta snow-wreath were updated in June 2020. While there are currently 26 documented element occurrences of Shasta snow-wreath in the CNDDB, some of these element occurrences consist of multiple parts, and are named as separate



Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,

Figure 2. Distribution of Shasta Snow-wreath Populations

California Department of Fish and Wildlife
Status Review of Shasta Snow-wreath (*Neviusia cliftonii*)

populations in Table 2 for the purposes of this Status Review (Lindstrand pers. comm. 2020; 2021). See the table in Appendix A of this Status Review for more detailed information on Shasta snow-wreath populations. The distribution of Shasta snow-wreath populations is shown on Figure 2. Using available population area estimates, Shasta snow-wreath populations cover an area of at least 106 ha (262 ac), and the majority of the occupied areas are on U.S. Forest Service land (Figure 3). Data on area occupied was not available for all populations of Shasta snow-wreath.

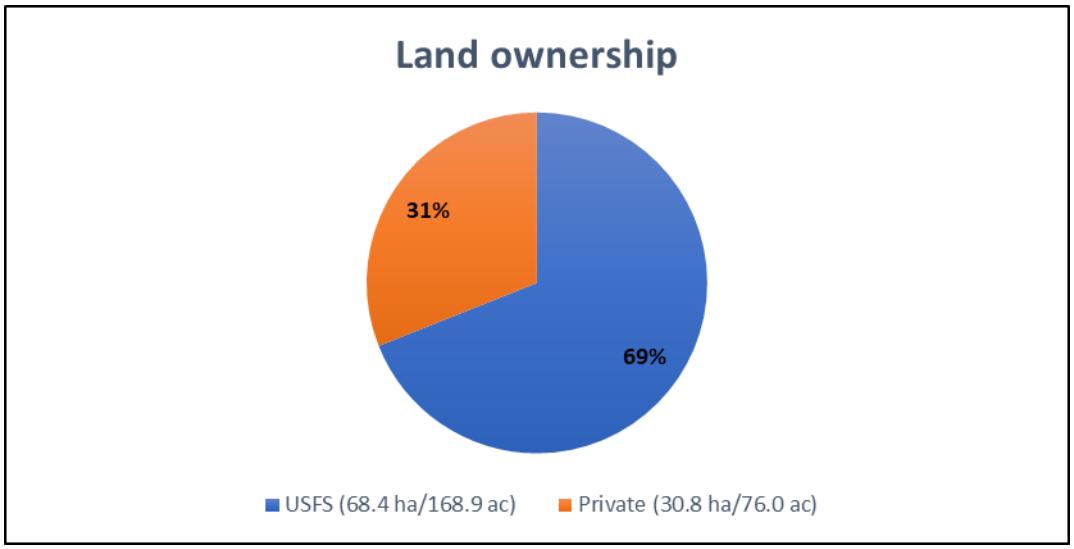


Figure 3. Land Ownership of Shasta Snow-wreath Populations
Area occupied by Shasta-snow wreath using available data. Some populations are not included in these estimates because the information was not available.

Life History

Shasta snow-wreath is a deciduous shrub that produces new leaves in the spring, generally flowers from April to May, and sheds its leaves in the fall (Heikens and Ertter 2012). The life history and ecology of Shasta snow-wreath has not been well-studied, and little information exists on the basic demography of this species or its response to common disturbances such as fire and herbivory (Jules et al. 2017). Little is known about the reproductive biology of Shasta snow-wreath, its life-cycle stages, time to maturity, or longevity of individual plants, but the available data suggests individuals are likely long-lived (DeWoody et al. 2012). It is unknown if Shasta snow-wreath is insect- or wind-pollinated. No pollinators have ever been documented and the blossoms lack detectable scent (Ertter and Shevock 1993; Shevock 1993; Lindstrand et al. 2020), although Department staff observed an iridescent blue-green beetle on an inflorescence at CNDDB element occurrence 1 in May 2010, and unidentified beetles were observed on flowers at CNDDB element occurrence 3 in 2021 (Lindstrand pers. comm. 2021). Shasta snow-wreath produces fruits called achenes (dry, one-seeded fruits), but the viability of any seeds is unknown. It is not known if the seeds are

produced from selfing (fertilization by pollen from the same plant) or from cross-pollination (fertilization by pollen from another plant). No seedlings of Shasta snow-wreath have been observed germinating in the wild, and germination attempts in controlled settings have been unsuccessful (Ertter and Shevock 1993; Stebbins 1993; Lindstrand et al. 2020). It is unknown if Shasta snow-wreath can reproduce by seed or what the limiting factors are for seed germination, but it is presumed that reproduction by seed is absent or exceedingly rare. Although Shasta snow-wreath occasionally produces seeds, apparently from sexual reproduction, it is thought to reproduce primarily vegetatively (i.e., asexually), with stems arising from the root system to form large thickets of clones (Ertter and Shevock 1993; Jules et al. 2017). The closely related Alabama snow-wreath has low seed viability and is known to reproduce only by vegetative spread (Freiley 1994).

Genetics

Species that reproduce primarily by vegetative means, such as Shasta snow-wreath, often exhibit very low genetic variability within populations (DeWoody et al. 2012). In addition, there is greater potential for populations to be genetically distinct from each other since species reproducing vegetatively generally have poor dispersal capability (Ellstrand and Roose 1987; Silvertown 2008). For clonal species, the term “genet” is used to describe a group of genetically identical individuals that all originate vegetatively from a single ancestor. Each unit (seemingly individual plant) is referred to as a “ramet”. Above ground, these ramets most often appear to be distinct individuals, but they may all be clones of the same genet (Figure 4).

DeWoody et al. (2012) conducted a genetics study to investigate the number of genets in Shasta snow-wreath populations, identified by allelic diversity at 17 loci. In this study, 21 populations from 17 Shasta snow-wreath element occurrences were sampled and genotyped (DeWoody et al. 2012; CNDDB 2021). The results of the study indicated that Shasta snow-wreath exhibits low genetic diversity across the species and within each population. The results indicated that five populations of Shasta snow-wreath were composed of a single genet each. The average number of genets per population was 3.14, and the maximum number of genets identified in a population was 15 (Table 2). Some genotypes occurred in multiple populations (DeWoody et al. 2012). The lack of genetic variation found within the populations is consistent with the typical vegetative reproduction of this species (DeWoody et al. 2012).

The study also found that populations of Shasta snow-wreath have high genetic differentiation between populations, with 85 percent of the genetic variance distributed among the populations. The F_{ST} (the level of genetic differentiation) between

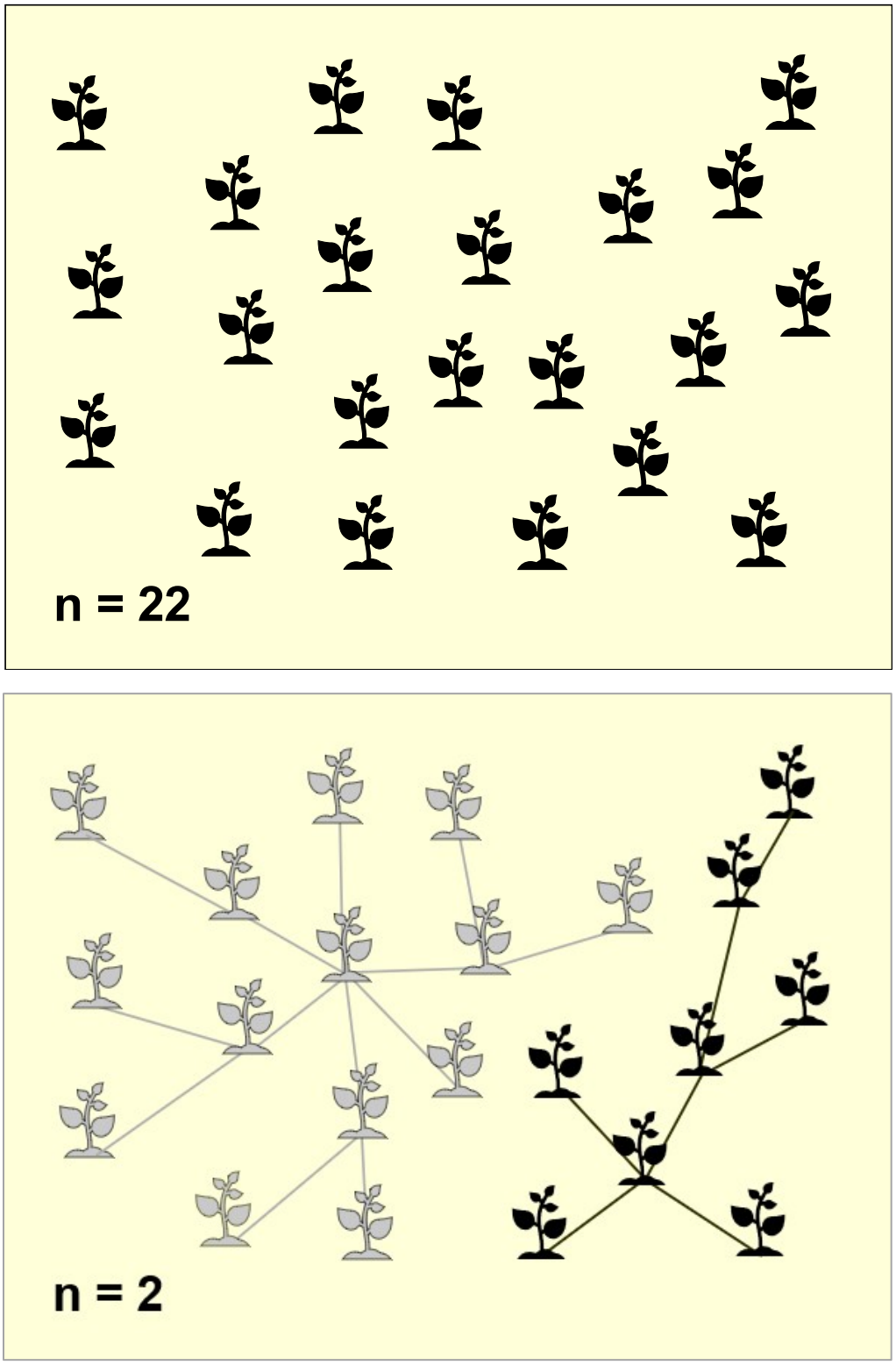


Figure 4. Relationship of Ramets to Genets. Top: Illustration of a population appearing as 22 individual plants (ramets). Bottom: Illustration showing there are only two genetically distinct individuals (genets), each made up of numerous clones.

populations was 0.8 in the study, which DeWoody et al. (2012) indicate is remarkably high. The high genetic differentiation between Shasta snow-wreath populations is typical for plants with limited seed or pollen dispersal mechanisms, and also indicates limited gene flow among populations (DeWoody et al. 2012). Diversity in Shasta snow-wreath is greater than that reported for the closely related congener, Alabama snow-wreath, which was shown to contain only one genotype per population sampled in a 1994 study (Freiley 1994).

Table 2. Number of Genets Compared to Ramets at Shasta Snow-wreath Populations Sampled in DeWoody et al. (2012).

CNDDB Occurrence #	Population Name	Estimated Population Size (Ramets) [+]	Genets
1	Cedar Creek	Not available (thousands?)	6
2	Squaw Creek	Not available	2
3	Ellery Creek	1000s	2
3	South of Ellery Creek (former EO #4)	1000s	4
5	Curl Creek	1729	4
6	Campbell Creek	1022	2
7	Low Pass	11,708	4
10	Cove Creek	1000s	4
10	South of Cove Creek	1000s	4
11	Ripgut Creek	100	2
12	Stein Creek	716 to “thousands”	15
14	Waters Gulch	20,100	2
15	Keluche Creek	500–1000	2
16	Blue Ridge West	4585	1
16	Blue Ridge Middle	20-30	1
16	Blue Ridge East	250-350	1
17	Flat Creek	1000s	3
18	Brock Creek	100+	3
19	Stein West	1000s	2
20	Shasta Caverns	<100	1
21	Jones Valley	3878	1
	TOTAL	**>48,808**	**48***

[+] Some CNDDB Occurrences document population estimates for multiple years, and some estimates are from partial surveys or a portion of the occurrence. The most recent and complete estimates were used in this table.

* The total number of genets is not a sum of all the genets reported from sampled populations, since some genets were reported as occurring at multiple populations. DeWoody et al. (2012) identified a total of 48 genets across all populations.

Overall, DeWoody et al. (2012) revealed low levels of genetic diversity in Shasta snow-wreath, potentially resulting from a lack of sexual reproduction in the species. Lower

levels of genetic variation are typically observed in rare and endemic species (species that occur in only one geographic location) than in closely related taxa with broader distributions (Gitzendanner and Soltis 2000; Cole 2003). The low levels of genotypic diversity of Shasta snow-wreath may be a consequence of the narrow range of the species, or it could be the result of historic population bottlenecks (DeWoody et al. 2012). The Shasta Lake area is known as a glacial and volcanic refuge in an ancient geologic landscape, and the area supports many endemic species (Lindstrand and Nelson 2006). The low allelic variation of Shasta snow-wreath could be the result of range contraction during the last glacial period and subsequent climate variations (Lindstrand and Nelson 2006), or it could reflect a reduction in genetic diversity resulting from construction of Shasta Dam and the filling of Shasta Lake (DeWoody et al. 2012), or both. Populations of Shasta snow-wreath were likely more connected prior to the construction of Shasta Dam, and Shasta Lake likely decreased the size of some populations and increased fragmentation of the populations, which can change the genetic structure of populations (Honnay and Jacquemyn 2007; Aguilar et al. 2008).

Similar-looking Plants

The growth form, leaves, and bark of Shasta snow-wreath closely resemble those of the common shrubs ninebark (*Physocarpus capitatus*) and oceanspray (*Holodiscus discolor*), two other species in the rose family (Figure 5) that grow in similar habitat and within the range of Shasta snow-wreath. The flowering season of Shasta snow-wreath is short, and it is easy to mistake Shasta snow-wreath for ninebark or oceanspray when it is not flowering. These similarities are likely why the species remained undiscovered by botanists until 1992 (Shevock et al. 1992; Taylor 1993).

Shasta snow-wreath looks very similar to its closest relative, Alabama snow-wreath. However, Alabama snow-wreath is restricted to the southeastern United States; thus, its range does not overlap with that of Shasta snow-wreath. The two species can be distinguished from each other based on the presence or absence of petals, number of stamens, and the length of sepals and styles (DeVore et al. 2005). Shasta snow-wreath flowers occasionally have petals, while Alabama snow-wreath flowers never have petals (Shevock et al. 1992; DeVore et al. 2005). The leaves are distinctive between the two species; Alabama snow-wreath leaves are longer with finer marginal teeth and Shasta snow-wreath leaves are shorter and wider, with coarser teeth (Shevock et al. 1992).

Habitat that may be Essential to the Continued Existence of the Species

Shasta snow-wreath primarily grows in riparian areas in the dense understory of shady montane hardwood-conifer and ponderosa pine forests, but is also found in foothill pine-blue oak woodland habitat (Shevock et al. 1992; Lindstrand and Nelson 2005b, 2006; Jules et al. 2017; CNDDB 2021). Shasta snow- wreath populations occur on limestone

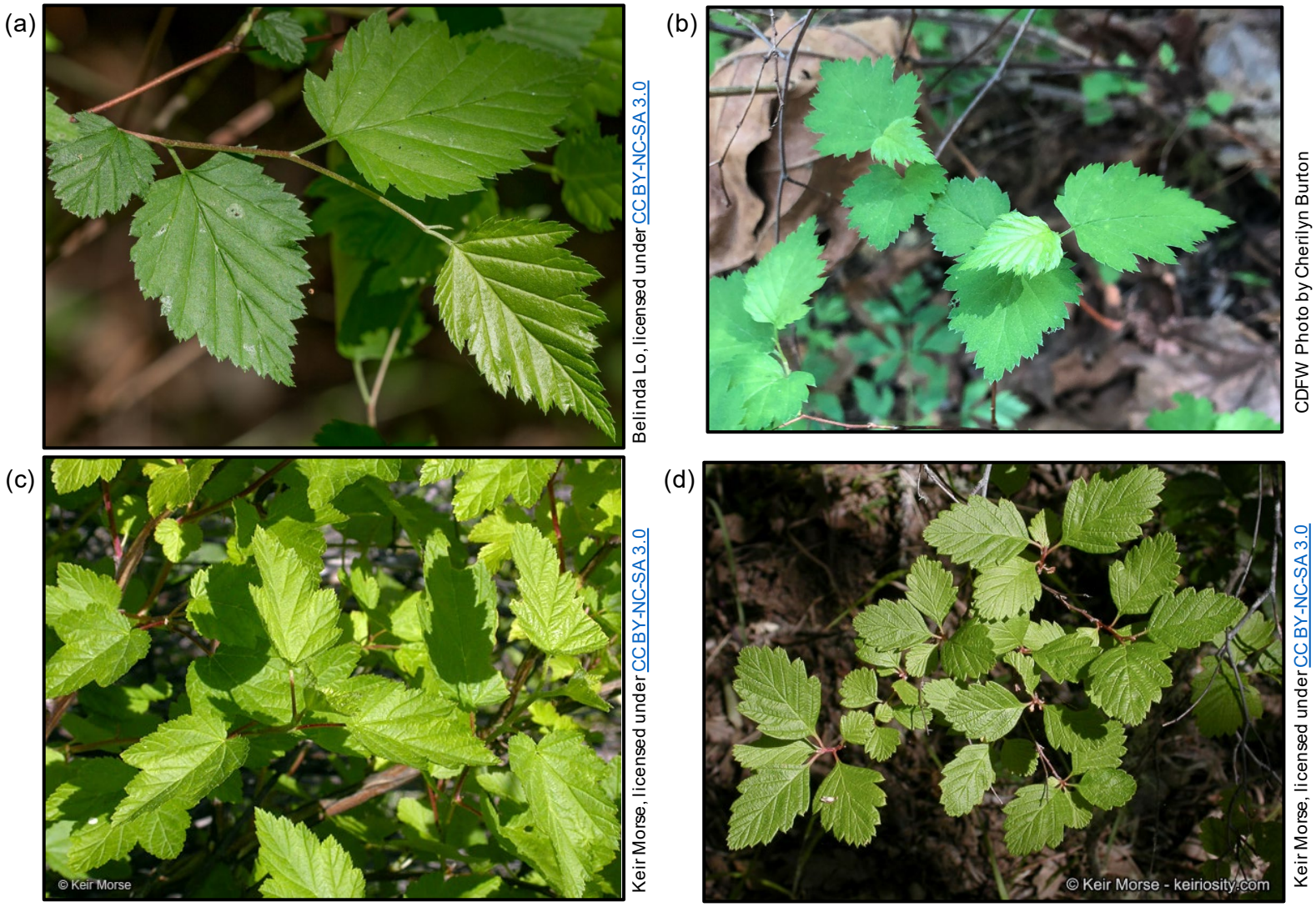


Figure 5. Shasta Snow-wreath and Similar Looking Species. (a) and (b) Shasta snow-wreath (*Neviusia cliftonii*). (c) Ninebark (*Physocarpus capitatus*). (d) Oceanspray (*Holodiscus discolor* var. *discolor*).

and a variety of substrates derived from metamorphic and igneous formations, such as shale, mudstone, and greenstone (Lindstrand and Nelson 2006; DeWoody et al. 2012; Jules et al. 2017). The Department's preliminary identification of the habitat that may be essential to the continued existence of Shasta snow-wreath includes: (1) habitats that fit the general habitat descriptions provided below, (2) habitats that are located at any of the known Shasta snow-wreath populations, and (3) habitats located at any Shasta snow-wreath populations that are discovered or established in the future.

Vegetation Communities

The Department uses A Manual of California Vegetation (Sawyer et al. 2009; CNPS 2021) to classify natural communities within California. However, the area where Shasta snow-wreath occurs has not yet been classified using A Manual of California Vegetation, so specific vegetation alliances and associations at Shasta snow-wreath populations have not yet been delineated. While the habitat where Shasta snow-wreath occurs is not yet classified in A Manual of California Vegetation (Sawyer et al. 2009; CNPS 2021), the species composition at populations suggests that the vegetation communities would likely be placed in the *Pseudotsuga menziesii* Forest and Woodland Alliance (Douglas fir forest and woodland), *Pinus ponderosa* Forest and Woodland Alliance (ponderosa pine forest and woodland), *Quercus kelloggii* Forest and Woodland Alliance (California black oak forest and woodland) or the *Quercus douglasii* Forest and Woodland Alliance (blue oak woodland and forest) (CNPS 2021). Figure 6 shows Shasta snow-wreath habitat.

The dominant tree species that are associated with Shasta snow-wreath include California black oak (*Quercus kelloggii*), Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*), big-leaf maple (*Acer macrophyllum*), canyon live oak (*Quercus chrysolepis*), ponderosa pine (*Pinus ponderosa*), California bay (*Umbellularia californica*), Oregon oak (*Quercus garryana*), and foothill pine (*Pinus sabiniana*), and dominant understory species include western poison oak (*Toxicodendron diversilobum*), wild rose (*Rosa* spp.), snowdrop bush (*Styrax redivivus*), wild mock orange (*Philadelphus lewisii*), and mountain dogwood (*Cornus nuttallii*). Other species associated with Shasta snow-wreath include California hazel (*Corylus cornuta* subsp. *californica*), California buckeye (*Aesculus californica*), western redbud (*Cercis occidentalis*), elk clover (*Aralia californica*), pacific madrone (*Arbutus menziesii*), and snowberry (*Symphoricarpos albus* var. *laevigatus*) (Ertter 1993; Lindstrand and Nelson 2005a; Jules et al. 2017; CNDDB 2021). The invasive Himalayan blackberry (*Rubus armeniacus*), encroaches into many Shasta snow-wreath populations, and French broom (*Genista monspessulana*) and Scotch broom (*Cytisus scoparius*) are invasive at several populations (CNDDB 2020; Department observation).

(a)

(b)

Figure 6. Shasta snow-wreath habitat. (a) Manzanita Hill, CNDDB element occurrence 22. (b) Ellery Creek, CNDDB element occurrence 3.

Geology and Soils

Shasta snow-wreath is found in the Klamath Mountains Geomorphic Province, which has rugged topography with prominent peaks and ridges reaching up to approximately 2400 meters (8000 feet) above sea level (California Geological Survey 2002). The Klamath Mountains Geomorphic Province is mainly underlain by ancient (65 million to 542 million years old) sedimentary, volcanic, and metamorphic rocks containing numerous ultramafic bodies (igneous rocks with high levels of magnesium and iron and only a very small amount of silica), and gabbroic and granitic rock intrusions (Hotz 1971). The Shasta Lake area is known as an ancient landscape relative to surrounding regions because it has been unaffected by glaciation and has not been overlain by volcanic material (Lindstrand and Nelson 2006).

Shasta snow-wreath was first discovered at the base of an exposed, north facing limestone outcrop (Shevock et al. 1992; Taylor 1993), and the species was originally described as being restricted to limestone (Shevock et al. 1992). The first seven Shasta snow-wreath populations were all found on limestone rock formations (Shevock 1993) because early surveys targeted suitable habitat on mapped limestone substrate (Shevock 1993), thus creating a bias toward populations occurring on limestone. Subsequent exploration of the region revealed populations on metamorphic and igneous formations, such as shale, mudstone, and greenstone (Lindstrand and Nelson 2006; DeWoody et al. 2012; Jules et al. 2017).

Climate, Hydrology, and other factors

Shasta snow-wreath occurs in western Shasta County, which experiences a Mediterranean climate with hot, dry summers and cool, wet winters. Winter temperatures at lower elevations are mostly above freezing, and summer temperatures are very high. Using 1943-2016 climate data from the nearest weather station at Shasta Dam, the average low/high during January, the coldest month, is 3.8º/11.4º C (38.9º/52.5º F), and the average low/high during July, the hottest month, is 20.2º/35.1º C (68.3º/95.2º F) (WRCC 2016). Areas at higher elevation receive 150 to 250 cm (60 to 100 in) of precipitation annually, but areas in the canyons receive only about half that of the mountain slopes (Sawyer 2006). About 90 percent of the precipitation falls between October and April, mostly as rain with very little snowpack. Only the highest nearby peaks hold snow into the summer. There are occasional summer thunderstorms which can release significant localized rain.

Shasta snow-wreath populations are found near Shasta Lake in the McCloud River, Cow Creek, Pit River, Sacramento River, and Squaw Creek watersheds (Lindstrand and Nelson 2006; CNDDB 2021). Populations are most often found in riparian zones, which are areas associated with rivers and streams that are transitional between terrestrial

and aquatic ecosystems. Shasta snow-wreath potentially receives a portion of its water from the water table associated with riparian zones. However, plants growing outside of the flood plain likely receive the majority of their water from precipitation.

Shasta snow-wreath grows in an area that historically experienced frequent wildfires (Taylor and Skinner 2003; Fry and Stephens 2006; Safford and Van de Water 2014), with an average fire return interval of 12 years (Jules et al. 2017). The California black oak woodlands and Pacific ponderosa pine – Douglas-fir forests where Shasta snow-wreath populations occur exhibit very high departures from pre-Euro-American settlement fire frequencies (Safford and Van de Water 2014; Jules et al. 2017) and the presence of the relatively fire-intolerant Douglas-fir in the overstory is indicative of prolonged fire suppression in the region/area (Jules et al. 2017).

In the Klamath Mountains, thunderstorms occur in the dry summer months (Newburn and Payne 2014) and lightning ignitions peak in July and August (Schroeder and Buck 1970). The long summer drought that is typical of the Mediterranean climate results in dry conditions that make the region highly susceptible to wildfire by August or September (Taylor and Skinner 1998). Skinner et al. (2006) indicate that lightning-caused fires account for the majority of area burned in recent decades. Lightning may ignite hundreds of fires over a 24-hour period. The large number of potential simultaneous ignitions coupled with poor access for fire-suppression activities and the steep terrain of the Klamath Mountains has led to instances where lightning-ignited fires burned for weeks to months over very large areas (Skinner et al. 2006). Fire severity is highly variable in the Klamath Mountains, primarily due to climatic variables and diverse topography and vegetation assemblages (Taylor and Skinner 1998; Skinner et al. 2006). Typically, high-severity burns occur on the ridgetops and upper portions of slopes, especially on west- and south-facing aspects. Lower slopes and north- and east-facing aspects generally experience low-severity fires, and middle slope areas experience intermediate severity patterns (Skinner et al. 2006).

Little information is available on the response of Shasta snow-wreath to common disturbances such as fire. In a study conducted by Jules et al. (2017), the populations of Shasta snow-wreath in areas with a relatively low canopy cover of live trees had the greatest number of ramets and the tallest stems, which could suggest that removal of the canopy by fire may have been a beneficial disturbance for this species. Reducing canopy cover either by restoring a more frequent fire interval through prescribed burning or employing mechanical fuels treatment could benefit Shasta snow-wreath. Shasta snow-wreath was observed resprouting following a low-intensity prescribed burn in 2011 (Jules et al. 2017).

Although Shasta snow-wreath occurs in a historically fire-prone region, only one of the 26 known element occurrences (consisting of 2 populations, Ellery Creek and South of Ellery Creek) of Shasta snow-wreath experienced a wildfire since the species' discovery in 1992. The Hirz fire burned through these two populations (CNDDB element occurrence 3) in 2018, with moderate to high intensity. Post-fire monitoring was initiated in 2018, and in 2019 Shasta snow-wreath was observed resprouting vigorously (Lindstrand et al. 2020), demonstrating that these Shasta snow-wreath populations were able to recover from a single fire event. Fire has been documented to stimulate seed germination in many shrub species in fire prone areas, but no seedlings of Shasta snow-wreath were observed, further supporting that this species only reproduces vegetatively (Lindstrand et al. 2020). During site visits in 2020 and 2021, the burned populations of Shasta snow-wreath were dense and portions of the populations were observed flowering (Lindstrand et al. 2020; Department observation).

ABUNDANCE AND POPULATION TRENDS

Shasta snow-wreath populations are reported as having population sizes ranging from 20 to approximately 20,000 (Jules et al. 2017; CNDDB 2021); however, these are estimates of the number of ramets (above ground stems) observed in each population, which represent clones of the same plant. DeWoody et al. (2012) identified a total of 48 genets (genetically distinct individuals) across 21 sampled populations, with the number of genets at each population ranging from 1-15. Genets are considered genetically unique individuals, and the number of genets is more representative of the number of unique individuals in a population than the number of aboveground stems. If the number of genets is used as an indicator of the number of individuals in Shasta snow-wreath populations, then the populations would be considered quite small (potentially as few as 1-15 individuals at each population).

Shasta snow-wreath has only been known to science since 1992, and little formal monitoring or research has been conducted on the species in the past 29 years. Anecdotal observations of Shasta snow-wreath populations suggest that populations have been relatively stable over the short term (Lindstrand pers. comm. 2021). However, there is no scientific monitoring data on Shasta snow-wreath's long term population trends. Jules et al. (2017) initiated monitoring of Shasta snow-wreath in 2011 at seven populations, and population data was collected between 2011 and 2013. Two to three years of data was collected from each population, and no significant difference was found in "ramet population size" between years (Jules et al. 2017). During the study, permanent monitoring plots were established, which provide the opportunity for future monitoring at these populations, but no additional monitoring has been reported from these locations. Lindstrand et al. (2020) also conducted two years of qualitative monitoring at two populations within one element occurrence (Ellery Creek and South of

Ellery Creek, CNDDB element occurrence 3) following the 2018 Hirz Fire. No other information on population monitoring activities is available.

Although long-term population monitoring has not been conducted for Shasta snow-wreath, the species likely experienced a significant reduction in distribution as a result of the construction of Shasta Dam in 1945 and the subsequent filling of Shasta Lake in 1948. It is very likely that populations of Shasta snow-wreath were connected by the riparian zones of the Sacramento, McCloud, and Pit rivers and their tributaries prior to the construction of Shasta Dam because many of the current Shasta snow-wreath populations reach their lower limit at the edge of Shasta Lake (Lindstrand and Nelson 2006; Jules et al. 2017). It is therefore likely that Shasta snow-wreath populations and habitat were eliminated by inundation from the rising waters of Shasta Lake following completion of Shasta Dam (DeWoody et al. 2012). At least six of the known populations were likely partially flooded by the creation of Shasta Lake (Lindstrand and Nelson 2006), but the extent of loss is unknown since this species and the extent of its distribution was not known when Shasta Lake was created in 1948.

FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE

Genetics, Reproductive Challenges, and Restricted Range

Low genetic diversity, reproductive challenges, and the restricted and isolated range of Shasta snow-wreath populations are considered significant factors affecting the ability of the species to survive and reproduce. Shasta snow-wreath populations exhibit low genetic diversity (DeWoody et al. 2012), likely resulting from predominantly vegetative reproduction over time. In addition, the lack of reproduction by seed limits the dispersal capability of the species, and the restricted and isolated distribution of Shasta snow-wreath populations presents additional challenges to its dispersal and persistence on the landscape.

Population sizes of Shasta snow-wreath, as estimated by the number of above ground stems in the populations, are reported as ranging from 20 plants to thousands of plants. However, the low genetic diversity of Shasta snow-wreath populations indicates that populations seemingly comprised of thousands of plants (ramets) may actually be comprised of just one or a handful of genetically unique individual plants (genets) (DeWoody et al. 2012). The study conducted by DeWoody et al. (2012) of 21 populations of Shasta snow wreath (from 17 CNDDB element occurrences) found that the number of genets per population sampled ranged from 1-15, with a mean of about 3 genets per population. Five of the sampled populations consisted of only a single genet, indicating that all of the seemingly individual plants were simply clones that were genetically identical.

Genetic diversity is an important factor in the viability of clonal species. Populations with high genetic diversity have a greater capacity to adapt to changing habitat or climate conditions either through adaptability that the species already possesses or via evolutionary change thus increasing their ability to persist (Hoffmann et al. 2005; Hoffmann and Sgro 2011). Low genetic diversity, as observed in Shasta snow-wreath populations, reduces adaptive capacity to adverse environmental conditions, diseases, and other disturbances, potentially leading to reduced survival (Lande and Shannon 1996; Hughes et al. 2008; de Witte and Stöcklin 2010; Hoffmann and Sgro 2011; Yang and Kim 2016).

Although Shasta snow-wreath plants produce seeds, no seedlings of this species have been observed (Lindstrand et al. 2020) and efforts to germinate seeds from a 1992 collection at the U.C. Botanical Garden were unsuccessful (Ertter and Shevock 1993), suggesting that Shasta snow-wreath may be incapable of reproducing by seed under current environmental conditions. No other attempts to germinate Shasta snow-wreath from seed have been reported. The apparent inability to produce viable fruits with any dispersal mechanism limits the dispersal capability of Shasta snow-wreath, which is confounded by the steep terrain and topography of its habitat and by human introduced impediments, such as roads, campgrounds, and Shasta Lake. Lack of sexual reproduction makes adaptation to changing conditions very challenging, since sexual reproduction promotes genetically diverse offspring through recombination, mutation, and gene flow from immigrants (Yang and Kim 2016). Evolutionary adaptation may be the only way that populations of rare species with limited dispersal capability can persist in the face of climate change (Hoffmann and Sgro 2011).

Shasta snow-wreath also occurs in isolated populations within a limited and restricted geographic range (Lindstrand and Nelson 2006; Jules et al. 2017; CNDDB 2021). The smaller a species' geographic range, the higher the probability that disturbances and environmental changes will affect a large enough portion of the species' range to jeopardize its persistence. Therefore, species with small geographic ranges, such as Shasta snow-wreath, tend to be more vulnerable to extinction from disturbances, environmental changes, random events, and other threats than species with widespread ranges (Purvis et al. 2000; Harris and Pimm 2007; Gaston and Fuller 2009; Hobohm et al. 2013; Pimm et al. 2014; Enquist et al. 2019; Staude et al. 2020).

Extinction debt refers to the future extinction of a species due to past disturbances. It can take a considerable amount of time for a population or species to diminish and disappear following disturbances such as habitat loss or degradation (Kuussaari et al. 2009). The probability and magnitude of extinction debt depends on several factors, such as the life history traits of a species, the spatiotemporal configuration of habitat patches, and the time since and nature of the alteration of the habitat. Empirical

evidence suggests that delayed extinctions are more likely in species with low turnover rates, such as in perennial plants versus annual plants. In addition, microhabitat specificity and the probability of dispersal of the species can also contribute to the probability of extinction debt (Kuussaari et al. 2009). The lack of genetic diversity in Shasta snow-wreath populations as assessed in the DeWoody et al. study may indicate that Shasta snow-wreath is a relict species that is not well adapted to its current refugia or that Shasta snow-wreath is a narrowly distributed species that is highly adapted to its habitat (Lindstrand and Nelson 2006; DeWoody et al. 2012). Geological events (e.g. glacial and/or volcanic activity) in surrounding regions may have led to the permanent isolation of Shasta snow-wreath to an area where it could persist for a long time as a relict species (Lindstrand and Nelson 2006), delaying its extinction (Jablonski 2002). Additional fragmentation of Shasta snow-wreath occupied habitat from the creation of Shasta Lake could also contribute to this potential risk of extinction, albeit delayed. The perennial, long-lived nature of Shasta snow-wreath, together with its isolated populations and low dispersal capabilities, creates a scenario where extinction debt is a possible phenomenon for this species. If Shasta snow-wreath is experiencing extinction debt, human-induced threats only accelerate the pace towards extinction, though humans may also be able to intervene to slow the time to extinction.

Habitat Modification and Destruction

Habitat loss at local, regional, and global scales is considered the primary cause for species extinctions worldwide (Wilcove et al. 1998; Randall and Hoshovsky 2000; Dirzo and Raven 2003; Rybicki and Hanski 2013).

The federal Bureau of Reclamation is proposing to raise the height of Shasta Dam to increase water storage capacity of the Shasta Lake reservoir, and the Shasta Lake Water Resources Investigation (SLWRI) Final Environmental Impact Statement (EIS) was completed for the project in 2015 (USDI BOR 2015b). The SLWRI Final Supplemental EIS was released on November 19, 2020. Shasta Lake currently stores approximately 561,000 hectare-meters (4.55 million acre-feet) of water and the maximum surface area of the lake covers an area of about 11,940 ha (29,700 ac). The preferred alternative would raise the dam by 5.6 m (18.5 ft), and would increase the height of the reservoir full pool by 6.3 m (20.5 ft) (USDI BOR 2015b). This vertical increase of 6.3 m (18.5 ft) will significantly increase the area of the reservoir and translates to the inundation of approximately 13,071 ha (32,300 ac) of land surrounding Shasta Lake that is presently not underwater and supports populations of Shasta snow-wreath or could be potential habitat (USDI BOR 2015b). The current maximum water surface elevation is 328 m (1076.2 ft) (USDI BOR 2021).

In its Final Feasibility Report (2015), the Bureau of Reclamation announced they would require cost-sharing partners to fund the project to raise the height of Shasta Dam.

Congress passed the Water Improvements Infrastructure for the Nation Act in 2016, requiring at least a 50 percent non-federal contribution from cost-sharing partners for the project (USDI BOR 2020). The Bureau of Reclamation has not secured a cost-share partner, as there have been challenges regarding a state agency assisting with the planning process (e.g., through CEQA analysis) due to the potential for the project to have an adverse effect on the free-flowing condition of the McCloud River or on its wild trout fishery, which is prohibited by the California Wild and Scenic Rivers Act (Carillo and Davis 2019). Despite these challenges to secure a cost-share partner, the Department considers the project to raise the height of Shasta Dam as having the potential to occur in the foreseeable future (i.e., by the end of the century), especially given the increased demand for water storage in California. Therefore, the Department is considering potential impacts from the project on Shasta snow-wreath as part of this Status Review.

If implemented, raising the height of Shasta Dam would directly impact portions of almost half (48 percent) of the known Shasta snow-wreath populations (from 50 percent of the known CNDDB element occurrences). Table 3 lists the area of direct impacts (inundation) to each population, which is based on the area that each Shasta snow-wreath population occupies.

The level of impact to Shasta snow-wreath populations resulting from the proposed project to raise Shasta Dam varies for each population, with the lowest proportion of impact at less than one percent (Table 3; Ellery Creek Population, part of CNDDB element occurrence 3). One small element occurrence (East of Stein Creek, element occurrence 24) consisting of approximately 20 to 30 stems would be completely inundated; this element occurrence is considered part of the Stein Creek population (element occurrence 12) because it is located downstream in the same drainage and within connected habitat (Lindstrand pers. comm. 2020). The Keluche Creek population (element occurrence 15) would also experience almost complete inundation (97 percent; see Table 3). This is a relatively small population (0.06 ha [0.15 acre]) and represents a small portion of the total area of all Shasta snow-wreath populations combined. Nevertheless, the population will be nearly eliminated if the Shasta Dam raise project is implemented, potentially losing important genetic diversity of the species along with it. At least eight populations will have impacts to more than 20 percent of their occupied area. When considering the impacted populations of Shasta snow-wreath, the proposed project to raise Shasta Dam, if implemented, would result in a loss of 3.8 percent of the total area of these populations. This equates to an approximately one percent loss of the species total. However, the project would impact almost half (48

Table 3. Direct Impacts to Shasta Snow-wreath Populations from the Proposed Project to Raise Shasta Dam

CNDDB Element Occurrence #	Population Name	Population Total Area (acres)	Area of Population Inundated (acres) +	Percent of Population Inundated
3	Ellery Creek	28.65*	0.047+	<1%
6	Campbell Creek	1.9*	0.04+	2%
10	Cove Creek	1.17	0.401+	34%
10	South of Cove Creek	0.16	0.149+	93%
12	Stein Creek	42.15+	0.469+	1%
15	Keluche Creek	0.15*	0.146+	97%
16	Blue Ridge West	1.11*	0.75+	68%
16	Blue Ridge East	0.03*	0.002+	7%
18	Brock Creek	1.38*	0.634+	46%
20	Shasta Caverns	0.08*+	0.018+	23%
21	Jones Valley	0.34*	0.015+	4%
24	East of Stein Creek (considered part of the Stein Creek population, CNDDB element occurrence #12)	0.01**	0.01++	100%
25	North of Marble Creek 1 and 2	1.28*	0.1++	8%
27	Bear Canyon	1.01++	0.06++	10%
28	Roberts Canyon	0.74++	0.21++	28%
	Total	80.16	3.05	3.8%

*Source: Detailed digital mapping data submitted to the CNDDB in shapefile format.
+ Source: SLWRI Final EIS (2015)
**Source: Lindstrand pers. comm. 2020
++Source: Lindstrand pers. comm. 2021

percent) of the known Shasta snow-wreath populations (from 50 percent of the known CNDDB element occurrences) to some extent.

Shasta Lake experiences a high level of recreational use including boating, fishing, and camping. Shasta Lake is also popular for houseboat rentals. Raising the height of Shasta Dam could lead to additional direct impacts and indirect impacts to Shasta snow-wreath and its habitat by increasing the amount of human activity at the newly created shoreline from campers, boaters, and other visitors to the area. An increase in human activity would cause disturbance of the area and could result in an increase in soil compaction, impacts to vegetation, and an increase in garbage and pollution. Increased disturbance also could lead to a degradation of habitat, creating conditions favorable to the spread of invasive species. However, the Shasta snow-wreath populations along the shoreline of Shasta Lake are generally steep, brushy, and

dominated by poison oak, and existing human disturbance is low in most of these areas (Lindstrand pers. comm. 2021).

The majority of the Shasta snow-wreath populations are located on U.S. Forest Service lands (see Figure 3 and Appendix A), which are managed with a focus on managing vegetation, restoring ecosystems, reducing hazards, and maintaining forest health (USFS 2021a). U.S. Forest Service forest managers use timber sales, as well as other vegetation management techniques such as prescribed fire, to achieve these objectives (USFS 2021b). Proposed projects by the U.S. Forest Service on their lands would be subject to review as part of the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. § 4321, et seq.) process, which requires analyzing and disclosing the significance of any impacts to sensitive resources, such as Shasta snow-wreath. However, the NEPA review process does not include a requirement to minimize or mitigate impacts, and future projects such as timber harvest or vegetation management on U.S. Forest Service lands could result in modification or destruction of Shasta snow-wreath habitat.

Six populations of Shasta snow-wreath are located partially or entirely on privately owned lands. Of these, four populations are at least partially on lands owned by Sierra Pacific Industries (SPI), a forest products company (CNDDB 2021; Digital Map Products 2021). Timber harvest is subject to the Z'berg-Nejedly Forest Practice Act of 1973 (Pub. Resources Code, § 4511 et seq.) and the California Forest Practice Rules (CFPRs) which are administrated by the California Department of Forestry and Fire Protection (CAL FIRE). CAL FIRE is the lead agency for approving timber harvesting plans, and the Department, Regional Water Quality Control Board, and California Geologic Survey have the opportunity to review and comment on these plans. The Forest Practice Act was enacted to ensure that logging is done in a manner that will preserve and protect our fish, wildlife, forests, and streams (CAL FIRE 2021). However, CAL FIRE does not require that impacts to unlisted species be fully mitigated to the standards that apply under CESA as a part of timber harvesting plan approval.

Timber harvest occurred within two of the four Shasta snow-wreath populations (CNDDB element occurrences 12 and 23) and near a third population (CNDDB element occurrence 22) between 2012 and 2015. At CNDDB element occurrence 12 (Stein Creek), timber harvest activities also included the construction of new access roads and crossings that resulted in impacts to several Shasta snow-wreath plants at two road crossings located across stream drainages and created disturbance in the area, increasing the potential for introducing and spreading non-native species. Portions of the Shasta snow-wreath population at CNDDB element occurrence 12 were protected during these timber harvest activities, and observations made during site visits over the

past two years report that the Shasta snow-wreath plants outside of the timber harvest area were observed in excellent condition (Lindstrand pers. comm. 2021).

Selection harvesting (uneven-aged management) of single trees took place at CNDDB element occurrence 23 (McCandless Gulch), and herbicide was also inadvertently applied the Shasta snow-wreath plants while targeting Himalayan blackberry. In addition to tree removal and the inadvertent herbicide application, timber operations along the edge of the Shasta snow-wreath element occurrence included creation of a tractor skid trail (Lindstrand pers. comm. 2021) and a small temporary landing where trees were skidded to for loading on trucks. Harvesting activities provided an opportunity to monitor the response of Shasta snow-wreath to timber harvesting activities. SPI established six permanent transects (five treatment and one control) at CNDDB element occurrence 23 in September 2014 in association with Timber Harvest Plan (THP) 2-13-059-SHA (McChicken THP). The treatment transects are in a selection harvest area, and two of these are in the area where herbicide was inadvertently applied. Initial observations suggested the herbicide was effective at killing Shasta snow-wreath, but follow-up monitoring for response to tree canopy reduction has not yet been conducted.

Timber harvest occurred near the third SPI-owned population during 2014 to 2015 (Manzanita Hill, CNDDB element occurrence 22), but the Shasta snow-wreath population was avoided and protected (Lindstrand pers. comm. 2020) (§ 916 et seq., Title 14, CCR). No timber harvest has been reported at the fourth population (Bear Gulch, CNDDB element occurrence 8) located partially on SPI property (CNDDB 2021). Recent timber harvest practices have implemented measures to minimize impacts to Shasta snow-wreath. However, future timber harvest in Shasta snow-wreath populations could pose a potential threat to this species without proper avoidance measures.

A portion of one Shasta snow-wreath population that is located on SPI property is also on private property owned by Stimple-Wiebelhaus Associates (Bear Gulch, CNDDB element occurrence 8), a construction and excavation company. No excavation is presently occurring on the property, but the plants are currently unprotected. One Shasta snow-wreath population (CNDDB element occurrence 9) occurs at the Fawndale Quarry, which is owned and operated by J.F. Shea Construction, Inc. The population is not within the current mining area, but mine expansion could impact Shasta snow-wreath. The other population of Shasta snow-wreath that is located partially on privately-owned property (Squaw Creek, CNDDB element occurrence 2) is owned by a private citizen (CNDDB 2021; Digital Map Products 2021). The population is located on a steep slope at the base of a limestone cliff upslope of a U.S. Forest Service Road. Development of this parcel is unlikely due to the topography (Lindstrand pers. comm. 2021), but the property is not currently managed.

One Shasta snow-wreath population (Waters Gulch, CNDDB element occurrence 14) is bisected by the Waters Gulch Trail, which was developed prior to the discovery of Shasta snow-wreath. Waters Gulch Trail was used as a fire line during a prescribed burn in the 1990s and the plants on both sides of the trail were cut above ground. The plants resprouted over the next several years (Kierstead pers. comm. 2021). The trail is also subject to impacts from trail maintenance; however, these impacts appear to be minimal and consist of pruning and cutting branches that encroach onto the trail. Cut stems along the trail were observed resprouting during a site visit conducted by Department staff in April 2021 (Department observation) (Figure 7). Another population (Low Pass, CNDDB element occurrence 7) grows along both sides of a historic jeep trail in the Devils Rock-Hosselkus Research Natural Area. Currently this jeep trail functions as a foot path (Lindstrand pers. comm. 2020). No information was found regarding maintenance of the jeep trail/foot path.

Invasive Species

Studies have not been conducted on the impact of invasive species on Shasta snow-wreath specifically; however, the negative impacts of plant invasions on Mediterranean ecosystems have been well documented (Gaertner et al. 2009; Fried et al. 2014). Invading alien species cause major environmental damages and losses and are a significant risk factor leading to the extinction of threatened and endangered species (Wilcove et al. 1998; Pimentel et al. 2005; Conser and Connor 2009). Invasive non-native plants present a complex threat to biodiversity that is difficult to manage and has long-lasting effects. North America has accumulated the largest number of naturalized plants in the world (van Kleunen et al. 2015), which are non-native plants that reproduce in the absence of human benefit and persist beyond initial colonization. Many non-native plant species have become established within California, dramatically changing the state's ecological landscape (Conser and Connor 2009). Many studies hypothesize or conclude that competition is the factor responsible for the observed negative impacts of invasive species on biodiversity (D'Antonio and Vitousek 1992; Wilcove et al. 1998); however, invasive species may also impact native ecosystems by altering environmental conditions and resource availability (D'Antonio and Vitousek 1992; Levine et al. 2003). Invasive species may threaten native populations through competition for light, water, or nutrients; allelopathic mechanisms; alteration of soil chemistry; thatch accumulation that inhibits seed germination and seedling recruitment; changes in natural fire frequency; disruptions to pollination or seed-dispersal mutualisms; changes in soil microorganisms; or other mechanisms (Levine et al. 2003). The magnitude of detrimental effects of invasive species in a Mediterranean climate, as is found in California, largely depends on characteristics of the invading species and the habitat being invaded (Fried et al. 2014). The invader's vegetative structure and ability

(a)

(b)

Figure 7. Shasta Snow-wreath Population at Waters Gulch (CNDDB Element Occurrence 14). (a) The Waters Gulch Trail that cuts through part of the Waters Gulch Shasta snow-wreath population at CNDDB element occurrence 14; (b) Shasta snow-wreath resprouting from cut stems along the edge of the trail.

to form dense patches influence the magnitude of impacts (Gaertner et al. 2009; Fried et al. 2014). Invasive species may also influence native species colonization rates and may thus lead to declines in local diversity over longer timescales (Yurkonis and Meiners 2004).

Invasive plant species, including Himalayan blackberry, French broom, and Scotch broom, have been documented at 13 of the Shasta snow-wreath populations (12 CNDDB element occurrences) (Lindstrand pers. comm. 2020; CNDDB 2021; Department observation). It is likely that these or other invasive plant species occur within other Shasta snow-wreath populations but have not been reported, especially Himalayan blackberry, which commonly grows in similar habitat as Shasta snow-wreath. Himalayan blackberry forms dense, impenetrable thickets, particularly along watercourses (Figure 8). Himalayan blackberry is highly competitive with other plants, and thickets produce such a dense canopy that other plants cannot germinate beneath them due to lack of light (Hoshovsky 2000). Scotch broom is a long-lived strongly competitive perennial shrub that grows in sunny sites, spreading rapidly through forest borders and along roadsides. Scotch broom can crowd out native species and has a seedbank that can remain viable for up to 30 years, making invasions difficult to control. Scotch broom also burns readily and carries fire into the tree canopy, increasing fire intensity (Bossard 2000).

Figure 8. Invasive Species. Himalayan blackberry invasion seen in the foreground at the Manzanita Hill Shasta Snow-wreath Population (CNDDB element occurrence 22).

Climate Change

Warming of the climate system is well-documented in climate science data, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The ocean and the atmosphere have warmed, sea level has risen, and the amounts of snow and ice have declined (IPCC 2014, 2021). Evidence indicates that anthropogenic climate change has already had widespread impacts on natural systems globally and the effects are growing (Parmesan and Yohe 2003; Parmesan 2006; IPCC 2014). Climate change poses a serious threat to California's ecosystems and will alter the fundamental character, production, and distribution of California's ecosystems during the current century (Knowles and Cyan 2002; Snyder et al. 2002; Snyder and Sloan 2005; Shaw et al. 2011). Climate change presents a major challenge to the conservation of California's natural resources, and it will intensify existing threats and create new threats to natural systems. Under all emissions scenarios considered by the Intergovernmental Panel on Climate Change, global warming of 1.5ºC (2.7ºF) and 2ºC (3.6ºF) will be exceeded during the 21st century unless deep reductions in emissions occur in the coming decades (IPCC 2021). Predicted changes over this century include higher average temperatures globally with more warming in the summer than the winter, with July to September increases of 1.5ºC (2.7ºF) to 6ºC (10.8ºF) (Pierce et al. 2018). Greater warming is expected inland than in coastal regions by as much as 4ºC (7.2ºF) (Pierce et al. 2018).

The climate in California is expected to be considerably warmer by the end of the century (Hayhoe et al. 2004; Loarie et al. 2008; Pierce et al. 2018). Increasing temperatures will result in more precipitation falling as rain instead of snow, variable precipitation and seasonal shifts, more extreme heat-waves, more intense droughts, and a reduced snowpack (Hayhoe et al. 2004; Mote et al. 2005; Yoon et al. 2015; Houlton and Lund 2018). In addition, the snowpack will melt much earlier in the year, and the higher snowlines will likely increase the frequency of flooding due to more frequent occasions of large-scale rainfall runoff (Kim et al. 2002; Miller et al. 2003; Hayhoe et al. 2004; Dettinger et al. 2009; Dettinger 2011). The decreased snowpack in the winter months will lead to a decrease in runoff in the late spring and summer, reducing total water availability (Snyder et al. 2002; Snyder and Sloan 2005). In addition, the higher extreme rainfall will bring more surface runoff and less groundwater recharge (Pierce et al. 2018).

California's climate oscillates between extremely dry and extremely wet periods relative to the rest of the United States because it derives a large portion of its annual precipitation from only a few large winter storms or "atmospheric rivers" (Dettinger 2011; Dettinger et al. 2011; Houlton and Lund 2018). Atmospheric rivers are long and narrow corridors of strong horizontal water vapor that are often associated with a low-level jet

stream ahead of the cold front of an extratropical cyclone (Dettinger 2011; Dettinger et al. 2011). In the last decade, Northern California experienced one of the worst droughts (2012-2016) in more than 1000 years, followed by the wettest winter on record (2016-2017) (Houlton and Lund 2018). Global climate change results in an increase in the atmosphere's capacity to "hold" water vapor, causing winter storms to carry more rain (Houlton and Lund 2018). Water cycles extremes are expected to intensify, with dry years becoming drier and wet years becoming wetter in the next several decades (Dettinger 2011; Yoon et al. 2015). In Northern California where Shasta snow-wreath occurs, annual precipitation is expected to remain about the same on average, or to increase slightly by the end of the century (Huang and Ullrich 2017; Pierce et al. 2018). However, the increasing intensity of extreme storms will likely increase the risk of large flood events, challenging water storage and flood control systems which were designed for historical climate patterns (Dettinger 2011; Dettinger et al. 2011; Houlton and Lund 2018; Pierce et al. 2018).

California's Fourth Climate Change Assessment, Sacramento Valley Regional Report (Houlton and Lund 2018) summarizes major changes in climate and climate-related risks and includes the area where Shasta snow-wreath occurs. The report predicts substantial impacts and risks on the Sacramento Valley Region, including rising temperatures, changing precipitation patterns and amounts, flooding, drought, and wildfire (Houlton and Lund 2018). No published climate change modeling has been carried out for the Shasta-Trinity National Forest or Shasta snow-wreath habitat specifically, but significant increases in nighttime temperatures and in maximum mean (daytime) temperatures were observed at the nearby Shasta Dam weather station when comparing historic (1900-1939) and modern (1970-2009) averages (Butz et al. 2015).

Natural populations are responding to global climate change through shifts in their geographical distribution and timing of growth and reproduction (Hoffmann and Sgro 2011) The distribution of vegetation in California is expected to move upslope and poleward, where it is able to, in response to climate change (Hayhoe et al. 2004; Loarie et al. 2008; Ackerly et al. 2010), and vegetation shifts driven primarily by temperature changes, such as reductions in the extent of alpine/subapine forest and the displacement of evergreen conifer forest by mixed evergreen forest, are predicted by the end of the century (Hayhoe et al. 2004). These shifts in vegetation and of timing of growth and reproduction are resulting in changes in community composition and the nature of species interactions (Hoffmann and Sgro 2011). Populations can avoid extinction by moving to nearby favorable habitat, overcoming stressful conditions through attributes the species already possesses (i.e., phenotypic plasticity), or by undergoing evolutionary adaptation (Hoffmann et al. 2005; Hoffmann and Sgro 2011; Stotz et al. 2021). Shasta snow-wreath faces severe limitations to dispersal and range shift since it is only known to reproduce through vegetative means, and it grows in areas

of steep terrain with topographical impediments to dispersal. These limitations restrict the ability of Shasta snow-wreath to disperse into nearby habitat in the face of climate change. In addition, its low genetic diversity decreases the likelihood of it possessing adaptable traits to withstand changing conditions, and the lack of sexual reproduction makes it nearly impossible for it to undergo evolutionary adaptation.

Department staff assessed the vulnerability of Shasta snow-wreath to climate change using the NatureServe Climate Change Vulnerability Index Version 3.02 (NatureServe 2016; CDFW 2021a). Factors contributing to the vulnerability assessment include barriers to dispersal and limited dispersal capability, the historical thermal niche of the species, and very low genetic variation. Based upon the Department's assessment, Shasta snow-wreath has a climate change vulnerability index value of Moderately Vulnerable (MV), indicating that available evidence suggests that abundance and/or range extent within the geographical area of the species is likely to decrease by the year 2050. However, some ecological and life history information used for the climate change vulnerability assessment is not yet known for Shasta snow-wreath. In particular, the Department does not know if Shasta snow-wreath can reproduce by seed or what the limiting factors are for seed germination, although it is presumed that reproduction by seed is absent or exceedingly rare. Furthermore, the Department does not know whether, or to what extent, competing plant species such as Himalayan blackberry and Scotch broom will be favored by projected future climates. Despite the lack of information about some of the ecological and life history information for Shasta snow-wreath, the confidence in the vulnerability index score is very high based on the results of the Monte Carlo simulation used in the index (Young et al. 2015).

Altered Fire Regimes

Following the fire suppression efforts of the past century, recent research has indicated that fire size and frequency are now increasing in western U.S. forests (Miller et al. 2012). Miller et al. (2012) noted the mean fire size, maximum fire size, and total area burned all increased over the period from 1910 to 2008 in northwestern California forests. They also reported the tendency of high severity fires to occur in years when region-wide lighting storms caused multiple ignitions, indicating that weather conditions in some years can favor widespread high intensity fires in northwestern California (Miller et al. 2012). The extent of the recent high-severity burns appears to be different than historic burning patterns, with more area burning at high intensity, and this is related, in part, to higher quantities and more homogeneous fuels caused by accumulation due to fire-suppression (Skinner et al. 2006).

Miller et al. (2012) suggest the pattern of recent high-severity fires could be the result of the changing climate plus increasing and more fire-prone fuel loads in some forest types, potentially driven by a combination of human-related factors such as fire

suppression and climate-driven factors such as drier fire seasons. The total area burned, number of fires, and severity of wildfires has been increasing in the Western U.S. due to anthropogenic climate change and forest management activities that promoted dense forests with higher fuel load accumulation (Butz et al. 2015; Abatzoglou and Williams 2016). Abatzoglou and Williams (2016) estimated that human-caused climate change contributed to an additional 4.2 million ha (10.4 million ac) of forest fire area during 1984-2015, nearly doubling the forest fire area expected in its absence. Williams et. al. (2019) found that during 1972–2018, California experienced a fivefold increase in annual burned area, mainly due to more than an eightfold increase in summer forest-fire extent. The increased atmospheric aridity caused by warming likely caused the increase in summer forest-fire area (Williams et al. 2019).

Disturbances, such as fire, shape forest ecosystems by influencing their composition, structure, and functional processes (Dale et al. 2001). Expanded areas of high-severity fire can impact tree regeneration, soil erosion, and water quality, which can greatly alter forest biodiversity and composition (CDFW 2021b). Major shifts in fire regime and fire suppression have had profound effects on vegetation structure and composition of plant communities, threatening at-risk species and habitat (Shaffer 2006). High-severity fire can affect the ability of an ecosystem to recover, create favorable conditions for the expansion of non-native invasive plant species, and lead to the long-term or permanent loss of habitat (CDFW 2021b). Although Shasta snow-wreath was observed vigorously resprouting following a single moderate to high intensity fire event (the 2018 Hirz fire) at the Ellery Creek and South of Ellery Creek populations (CNDDB element occurrence 3), the long-term effects on Shasta snow-wreath populations due to potential changes in the forest and woodland communities resulting from altered fire regimes is unknown, but changing community structure could affect the ability of Shasta snow-wreath to persist.

REGULATORY AND LISTING STATUS

Federal

Shasta snow-wreath is not currently listed under the federal Endangered Species Act (ESA); however, a petition to list Shasta snow-wreath as endangered under the ESA was received by the U.S. Fish and Wildlife Service on October 3, 2019. On March 24, 2021, the U.S. Fish and Wildlife Service found that the petition presented substantial scientific or commercial information indicating that listing Shasta snow-wreath may be warranted, and announced plans to initiate a review of Shasta snow-wreath to determine if listing is warranted (USFWS 2021). Shasta snow-wreath is currently under review by the U.S. Fish and Wildlife Service.

Shasta snow-wreath is designated as a U.S. Forest Service Sensitive Species by the Shasta-Trinity National Forest. Forest Service Sensitive Species are plant and animal species for which population viability is a concern as evidenced by a downward trend in populations or in habitat capability to support the species (USDA 2005). The goal of sensitive species designation is to develop and implement management practices so these species do not become threatened or endangered and to prevent trends toward endangerment that would result in a federal listing. Management decisions by Shasta-Trinity National Forest are not to result in a trend towards federal listing or loss of viability of Shasta snow-wreath (USDA 2005).

State

On May 1, 2020, the Commission published its Notice of Findings for Shasta snow-wreath in the California Regulatory Notice Register, designating this species as a candidate pursuant to CESA. The provisions of CESA apply to Shasta snow-wreath while it is a candidate species (Fish & G. Code, § 2085). CESA prohibits the import, export, take, possession, purchase, or sale of Shasta snow-wreath or any part or product of thereof, except in limited circumstances, such as through a permit or agreement issued by the Department under the authority of the Fish and Game Code. For example, the Department may issue permits that allow the incidental take of listed and candidate species if the take is minimized and fully mitigated, the activity will not jeopardize the continued existence of the species, and other conditions are met (Fish & G. Code, § 2081 subd. (b)). The Department may also authorize the take and possession of Shasta snow-wreath for scientific, educational, or management purposes (Fish & G. Code, § 2081 subd. (a)).

Section 15380(b) of the California Environmental Quality Act (CEQA) Guidelines state that a species is “rare” when it exists in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens. Because of the small number of populations and the threats facing Shasta snow-wreath, the species meets these criteria under CEQA. Any state, local, and other (non-federal) governmental actions with potential to affect the environment would be subject to review under CEQA and would be required to consider and disclose impacts to this species.

Natural Heritage Program Ranking

Natural heritage programs provide location, natural history, and rarity status information on special status plants, animals, and natural communities to the public, government agencies, and conservation organizations. There are more than 80 natural heritage programs throughout the western hemisphere that make up a network of similar programs overseen by NatureServe (CNDDB 2020). California’s natural heritage

program is the CNDDB. All natural heritage programs use the same ranking methodology originally developed by The Nature Conservancy and now maintained by NatureServe (Faber-Langendoen et al. 2012). This ranking methodology consists of a global conservation status rank describing the status of a given taxon over its entire distribution, and a subnational (i.e., state) conservation status rank describing the status of the taxon over its state distribution (NatureServe 2021). Both global and subnational ranks reflect a combination of rarity, threat, and trend factors. Shasta snow-wreath has been assigned a global rank of G2 and a subnational rank of S2 (CNDDB 2021), indicating that the species is imperiled both within California and throughout its entire range, with a high risk of extinction due to a very restricted range, very few populations, steep declines, or other factors making it vulnerable to extirpation.

California Rare Plant Rank

Some plants in California are assigned a California Rare Plant Rank (CRPR) to identify them as species of conservation concern and to aid in analyses of projects for CEQA purposes. The Department works in collaboration with The California Native Plant Society (CNPS) and botanical experts throughout the state to assign rare and endangered plants a CRPR reflective of their status. Shasta snow-wreath has been assigned a CRPR of 1B.2 (CNDDB 2021). Plants with a CRPR of 1B are rare throughout their range with the majority of them endemic to California. Most of the plants that are ranked 1B have declined significantly over the last century. The threat code extension of “2” indicates that the species is moderately threatened in California, with 20 to 80 percent of occurrences threatened or a moderate degree and immediacy of threat (CNPS 2020).

EXISTING MANAGEMENT EFFORTS

There are currently no range-wide management efforts for Shasta snow-wreath.

National Forest Service Lands

Twenty-four populations (nineteen element occurrences) of Shasta snow-wreath are located entirely on U.S. Forest Service lands, and two populations are partially on U.S. Forest Service lands on the Shasta-Trinity National Forest. The U.S. Forest Service manages their forests with a focus on managing vegetation, restoring ecosystems, reducing hazards, and maintaining forest health (USFS 2021a). U.S. Forest Service forest managers use timber sales, as well as other vegetation management techniques such as prescribed fire, to achieve these objectives (USFS 2021b). Land and Resource Management Plans (LMRPs) are prepared to guide management of individual national forests. The LRMP for the Shasta-Trinity National Forest (USDA 1995) identifies Shasta snow-wreath as a sensitive and endemic plant on the forest but does not include

specific provisions to protect the species. The LRMP indicates that Species Management Guides have been developed and are being implemented for plant species of interest, such as Shasta snow-wreath, but no further information could be found on the Species Management Guide for this species. Since Shasta snow-wreath is designated as a U.S. Forest Service Sensitive Species, management decisions by Shasta-Trinity National Forest are not to result in a trend towards federal listing or loss of viability of the species or its habitat (USDA 2005). U.S. Forest Service policies for designated sensitive species include reviewing and disclosing impacts of federal activities on these species as part of the NEPA process and analyzing the significance of any impacts to these species or their habitat. However, the NEPA review process does not include a requirement to minimize or mitigate impacts to the species.

One population (CNDDB element occurrence 17) of Shasta snow-wreath is located within the Devils Rock-Hosselkus Research Natural Area established by the U.S. Forest Service (USFS ALP 2015b; CNDDB 2021). Research Natural Areas include a network of federally-administered public lands that are managed with the purpose of maintaining the natural features for which they were established and to maintain natural processes. Non-manipulative research and monitoring activities are encouraged in Research Natural Areas (USDA 2014). Another population (CNDDB element occurrence 7) of Shasta snow-wreath is located partially within the Devils Rock-Hosselkus Research Natural Area and partially in an area of the Shasta-Trinity National Forest with no special designation (USFS ALP 2015b). Sixteen Shasta snow-wreath populations are located entirely within the Whiskeytown-Shasta-Trinity National Recreation Area (USFS ALP 2015a). The primary purposes of the National Recreation Area are for public outdoor recreation benefits and the conservation of scenic, scientific, historic, and other values which contribute to public enjoyment of the recreation resources (USDA 2014). Another Shasta snow-wreath population is located partially within the Whiskeytown-Shasta-Trinity National Recreation Area and partially within an area of the Shasta-Trinity National Forest with no special designation (USFS ALP 2015a).

Monitoring

Shasta snow-wreath has only been known to science since 1992, and little formal monitoring or research has been conducted on the species in the past 29 years. Jules et al. (2017) initiated monitoring of Shasta snow-wreath 2011 at seven populations, and population data was collected between 2011 and 2013. During the study, permanent monitoring plots were established, which provide the opportunity for future monitoring at these populations, but no additional monitoring has been reported at these locations. Lindstrand et al. (2020) also conducted two years of qualitative monitoring at two populations (Ellery Creek and South of Ellery Creek, CNDDB element occurrence 3) following the 2018 Hirz Fire. In addition, SPI initiated monitoring in 2014 in an area to be harvested at CNDDB element occurrence 23 (McCandless Gulch) using monitoring

methods similar to Jules et al. (2017). Seven permanent monitoring plots were established in this population. Although many of the populations have been observed in recent years and qualitive updates (e.g., habitat condition) have been submitted to the CNDDB, no other information on quantitative population monitoring activities was available.

SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF SHASTA SNOW-WREATH IN CALIFORNIA

CESA directs the Department to prepare this report regarding the status of Shasta snow-wreath based upon the best scientific information available to the Department (Fish & G. Code, § 2074.6). CESA's implementing regulations identify key factors that are relevant to the Department's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: 1. present or threatened modification or destruction of its habitat; 2. overexploitation; 3. predation; 4. competition; 5. disease; or 6. other natural occurrences or human-related activities" (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and Game Code provide key guidance to the Department's scientific analysis. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]" (*Id.*, § 2067).

The preceding sections of this Status Review report describe the best scientific information available to the Department, with respect to the key factors identified in the California Code of Regulations. The section below considers the significance of any threat to the continued existence of Shasta snow-wreath for each of the factors.

Present or Threatened Modification or Destruction of Habitat

Shasta snow-wreath populations are threatened by impacts from the potential project to raise the height of Shasta Dam. It is likely that Shasta snow-wreath populations were more widespread and have already been eliminated or reduced by construction of Shasta Dam and the filling of Shasta Lake in the 1940s. Although impacts to populations are considered small in relationship to total area of occupied habitat, portions of almost half (48 percent) of the known Shasta snow-wreath populations (13 of

the 26 [50 percent] CNDDB element occurrences) will be impacted to some extent if the project to raise Shasta Dam is approved. One population will be completely inundated, and another will be almost completely eliminated, which is significant since only 31 populations are known to exist. In addition to direct inundation from the rising waters, there could be indirect impacts from increased human use at the new lake shore, as well as unforeseeable effects that extend further into the population from altered hydrology and microhabitat conditions.

Although current impacts by timber harvest activities are relatively minor, some practices in Shasta snow-wreath occupied habitat have potential to impact this species, including road construction, changes in tree canopy, accidental herbicide application, and creation of conditions favorable to the introduction and establishment of non-native species through soil disturbance and heavy equipment operations. Additionally, expansion of the operation area of the Mountain Gate quarry could impact the population at this location.

The Department considers modification and destruction of habitat to be a significant threat to the continued existence of Shasta snow-wreath. The special protection and management efforts required by CESA could reduce the effects of development and other human activities on Shasta snow-wreath.

Overexploitation

Cuttings of Shasta snow-wreath have been collected by botanists and gardeners for propagation and cultivation in home gardens. Shasta snow-wreath is also available for purchase in some nurseries (Calscape 2021). However, collection activities do not appear to be extensive and do not appear to be threatening populations of Shasta snow-wreath. The Department does not consider overexploitation to be a significant threat to the continued existence of Shasta snow-wreath.

Predation

Although it is likely that some herbivory occurs on Shasta snow-wreath, the Department could not find any evidence that herbivory or predation is a threat to the species. The Department does not consider predation to be a significant threat to the continued existence of Shasta snow-wreath.

Competition

Invasive plant species have been documented to pose serious threats to biodiversity around the world and are a particularly pervasive problem in Mediterranean-type habitats like those in California. Himalayan blackberry, French broom, Scotch broom, and other invasive plants occur within and adjacent to Shasta snow-wreath populations.

The Department considers competition with invasive plant species, particularly Himalayan blackberry and Scotch broom, to be a significant threat to the continued existence of Shasta snow-wreath.

Disease

There are no diseases known to be threats to the continued existence of Shasta snow-wreath. The Department does not consider disease to be a significant threat to the continued existence of Shasta snow-wreath.

Other Natural Occurrences or Human-related Activities

Shasta snow-wreath faces a number of significant threats to its persistence from reproductive and life-history challenges. The low genetic diversity of Shasta snow-wreath populations makes it less adaptable to changing environmental conditions or other factors, such as disease or climate change. Limited dispersal mechanisms of Shasta snow-wreath due to the lack of reproduction from seed and the steep topographical impediments of the area severely restrict Shasta snow-wreath from dispersing to new habitats, making it more susceptible to population reductions or extirpations resulting from climate change or other disturbances. The perennial, long-lived nature of Shasta snow-wreath, together with its isolated populations and low dispersal capabilities, creates a scenario where extinction debt is also a possible phenomenon for this species, and human-induced threats may accelerate the pace towards extinction. The Department does not expect that the special protection and management efforts required by CESA would reduce the effects of reproductive and life-history challenges on Shasta snow-wreath.

Shasta snow-wreath habitat is also threatened by climate change. As the climate system warms, potentially suitable habitat is expected to shift upwards in elevation to upstream areas, and suitable Shasta snow-wreath habitat will likely be reduced. As temperatures warm, the lower elevation habitat where Shasta snow-wreath occurs may become unsuitable for the species as the climate conditions it is currently found in are pushed farther upstream to higher elevations. If the current habitat becomes unsuitable due to climate change, there are three ways in which Shasta snow-wreath can persist: (1) disperse into nearby favorable habitat; (2) endure the changes through attributes the species already possesses (i.e., phenotypic plasticity); or (3) undergo evolutionary adaptation. Shasta snow-wreath faces severe limitations to dispersal and range shift since it is only known to reproduce through vegetative means, and it grows in areas of steep terrain with topographical impediments to dispersal. Due to these limitations, it is unlikely that Shasta snow-wreath could disperse into nearby habitat in the face of climate change. In addition, its low genetic diversity decreases the likelihood of adaptation, and the lack of sexual reproduction makes it less likely to undergo

evolutionary adaptation. The Department does not expect that the special protection and management efforts required by CESA would reduce the effects of climate change impacts on Shasta snow-wreath.

Chance events, such as the inadvertent application of herbicide during efforts to control interspersed non-native species or failure to implement specified protective measures for land management activities are possible and present an additional threat to Shasta snow-wreath.

The Department considers other natural occurrences or human-related activities described above to be a significant threat to the continued existence of Shasta snow-wreath.

SUMMARY OF KEY FINDINGS

Shasta snow-wreath is an uncommon species that is only known from 31 populations (26 CNDDB element occurrences) near Shasta Lake. The populations vary in extent and were likely larger and more connected prior to the construction of Shasta Dam and the filling of Shasta Lake in the 1940's. Shasta snow-wreath has demonstrated very low genetic diversity within populations. Populations seemingly comprised of hundreds to thousands of plants could actually be comprised of clones of as few as 1-15 genetically distinct individuals within each population. When considering the number of genets or actual individuals, Shasta snow-wreath populations are quite small. Species with small population sizes are highly vulnerable to extinction due to stochastic (chance) demographic, environmental, and genetic events. In addition, populations with low genetic diversity are vulnerable to extirpation due to changing environmental conditions, and the threat of climate change compounds this risk for Shasta snow-wreath. Shasta snow-wreath appears incapable of reproducing by seed, limiting its ability to expand into nearby habitat, which threatens its persistence, especially with the predicted changing climate. Extinction debt is also a possible phenomenon for Shasta snow-wreath, which is considered a relict species, or a "living fossil" remaining from a formerly more widespread group whose close relatives have gone extinct.

Populations of Shasta snow-wreath are threatened by the encroachment of aggressive invasive species, such as Himalayan blackberry and Scotch broom. In addition, the proposed project to raise Shasta Dam would result in a rising lake level that would inundate portions of half of the known Shasta snow-wreath populations. Although the area of impact from the proposed project to raise Shasta Dam is small, any impacts could result in a loss of important genetic diversity of Shasta snow-wreath and increase its vulnerability to extinction.

Shasta snow-wreath faces a number of threats to its survival. An endangered species is one that is in serious danger of becoming extinct throughout all or a significant portion of its range (Fish & G. Code, § 2062), and a threatened species is one that, although not currently faced with extinction, is likely to become an endangered species in the foreseeable future in the absence of protection by CESA (Fish and G. Code § 2067). Although Shasta snow-wreath is not currently faced with extinction, it is at risk from invasive plants, inability to reproduce and disperse by seed, stochastic (chance) events due to low genetic diversity and small population sizes, modification or destruction of habitat, and potentially from effects of altered fire regime and climate change, and it could become an endangered species in the foreseeable future. The information available to the Department regarding the status of Shasta snow-wreath indicates that there are significant threats to the continued existence of the species.

RECOMMENDATION FOR PETITIONED ACTION

CESA directs the Department to prepare this report regarding the status of Shasta snow-wreath in California based upon the best scientific information available to the Department (Fish & G. Code, § 2074.6). CESA also directs the Department to indicate in this Status Review whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). In addition to evaluating whether the petitioned action to list Shasta Snow-wreath as endangered is warranted, the Department also considered whether listing the species as threatened under CESA is warranted.

Under CESA, an endangered species is defined as “a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (Fish & G. Code, § 2062). A threatened species is defined as “a native species or subspecies…that although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [CESA]” (Fish and G. Code § 2067).

The Department includes and makes its recommendation in this Status Review as submitted to the Commission in an advisory capacity based on the best available science. Based on the criteria described above, the best scientific information available to the Department indicates that Shasta snow-wreath, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by CESA. The Department recommends that listing Shasta snow-wreath as threatened under CESA is warranted at this time.

PROTECTION AFFORDED BY LISTING

It is the policy of the state to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052). If listed under CESA, unauthorized "take" of Shasta snow-wreath will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier "take" is defined under CESA as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (*Id.*, § 86). Any person violating the take prohibition would be punishable under state law. The Fish and Game Code provides the Department with related authority to authorize "take" under certain circumstances (*Id.*, §§ 2081, 2081.1, 2086, 2087, 2089.6, 2089.10 and 2835). As authorized through an incidental take permit, however, impacts of the taking of Shasta snow-wreath caused by the activity must be minimized and fully mitigated according to state standards.

Additional protection of Shasta snow-wreath following listing would also occur during required public agency environmental review under CEQA, and its federal counterpart, NEPA. CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, threatened, and rare special status species. Under CEQA's "substantive mandate," for example, state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate, and the Department's regulatory jurisdiction generally, the Department expects related CEQA and NEPA review will likely result in increased information regarding the status of Shasta snow-wreath in California and result in updated occurrence and abundance information for individual projects. Where significant impacts are identified under CEQA, the Department expects project-specific required avoidance, minimization and mitigation measures will also benefit the species. While both CEQA and NEPA would require analysis of potential impacts to Shasta snow-wreath regardless of its listing status under CESA, the laws contain specific requirements for analyzing and mitigating impacts to listed species. In common practice, potential impacts to listed species are examined more closely in CEQA and NEPA documents than potential impacts to unlisted species. State listing, in this respect, and required consultation with the Department during state and local agency environmental review under CEQA, is also expected to benefit the species in terms of related impacts for individual projects that might otherwise occur absent listing. However, since many of the Shasta snow-wreath occurrences are on land under federal jurisdiction, and only actions that require discretionary approval by a state or local agency trigger CEQA, it is unlikely that there will be many actions triggering CEQA environmental review affecting the species on those lands.

If Shasta snow-wreath is listed under CESA, it may increase the likelihood that state and federal land and resource management agencies will allocate funds towards protection and recovery actions. However, funding for species recovery and management is limited, and there is a growing list of threatened and endangered species. Listing under CESA would also increase Shasta snow-wreath's eligibility for recovery or scientific research grants. Lastly, in common practice, many efforts (e.g., policy and regulation development, staffing allocations) prioritize listed species.

MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES

CESA directs the Department in its Status Review to recommend management activities and other recommendations for recovery of Shasta snow-wreath (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). The utility of current data on Shasta snow-wreath is limited by being largely anecdotal and qualitative. Studies designed to provide quantitative data on Shasta snow-wreath populations and the factors that affect the potential for Shasta snow-wreath to survive and reproduce are necessary for species management and conservation. Department staff generated the following list of recommended management actions and recovery measures to achieve conservation of Shasta snow-wreath. The Department recommends that the following actions be coordinated by the U.S. Forest Service as the primary land manager, in cooperation with private landowners, the U.S. Fish and Wildlife Service, the Department, researchers, and tribal and other partners.

- Convene a working group or recovery team to complete and implement a recovery plan for Shasta snow-wreath in collaboration with the U.S. Fish and Wildlife Service (Fish & G. Code § 2079.1);
- Research the reproductive system of Shasta snow-wreath, specifically factors related to self-compatibility, pollination, seed viability, germination, and recruitment, to inform potential future introductions or population expansions;
- Conduct additional research on genetic diversity within and between all known Shasta snow-wreath populations;
- Design and conduct population biology studies to determine characteristics of historic genetic diversity within the species and to determine if present diversity is relictual or novel;
- Implement an invasive species early detection and removal program at Shasta snow-wreath populations where invasive species are not yet established;
- Implement an invasive species removal program to control Himalayan blackberry, Scotch broom, and other aggressive invasive species at Shasta snow-wreath populations with established infestations;

- Conduct habitat modeling using geographic information systems or another comparable method to determine the locations of suitable habitat in and around the current range of Shasta snow-wreath, and conduct focused surveys for additional populations/occurrences;
- Collect and propagate Shasta snow-wreath cuttings from individual genets and maintain plants in living collections at Department-permitted botanical gardens to conserve the species' genetic diversity;
- Design and implement a standardized, range-wide search for Shasta snow-wreath seedlings throughout its habitat;
- Design and implement population monitoring and adaptive management programs for the Shasta snow-wreath populations to determine if habitat suitability or occupied habitat is being reduced or remaining stable. Ensure that monitoring results trigger appropriate management responses such as implementing other measures to control invasive species or controlling recreational activities. Make the data and reports from monitoring and adaptive management programs available to resource agencies and to those who are directly involved in Shasta snow-wreath management;
- Implement a program to detect Shasta snow-wreath population trends using statistically-valid population estimates.

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APPENDIX A: Summary of Shasta Snow-wreath Populations and Threats

Summary of Shasta Snow-wreath (*Neviusia cliftonii*) Populations and Threats

(USDI BOR 2015b; CNDDB 2021; Digital Map Products 2021)

CNDDB Element Occurrence #	Population Name	Size (acres)	Estimated Population Size (Ramets)**	Year(s) of Population Estimate(s)**	Ownership	Notable Threats/Notes
1	Cedar Creek	Not available	Not available	N/A	State of California	Himalayan blackberry (*Rubus armeniacus*) occurs in and near the population (Department observation).
2	Squaw Creek	19.6*	Not available	N/A	USFS-Shasta-Trinity National Forest, Private	Himalayan blackberry occurs near the population and is prevalent in the vicinity (Lindstrand pers. comm. 2020).
3	Ellery Creek/South of Ellery Creek (former EO #4)	41.85*	1000s	2019	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam; Himalayan blackberry and French broom (*Genista monspessulana*) occur here. Includes former CNDDB element occurrence #4. Considered 2 populations.
4	N/A					Subsumed into CNDDB element occurrence #3
5	Curl Creek	33.07*	1729	2011–2013	USFS-Shasta-Trinity National Forest	
6	Campbell Creek	1.9*	1022	2011–2013	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam; Himalayan blackberry occurs near the downstream-most portion of the population and could potentially spread.
7	Low Pass	51.9*	11,708	2011 - 2013	USFS-Shasta-Trinity National Forest	Occurrence is found along both sides of a historic jeep trail that is functionally a foot trail. Invasive Himalayan blackberry present within and adjacent to the population.

CNDDB Element Occurrence #	Population Name	Size (acres)	Estimated Population Size (Ramets)**	Year(s) of Population Estimate(s)**	Ownership	Notable Threats/Notes
8	Bear Gulch	<8.8^	1000–1500	2019	Private (Stimpel-Wiebelhaus and Sierra Pacific Industries [SPI])	Extensive Himalayan blackberry growth occurs along the Bear Gulch corridor, including plants within and near the Shasta snow-wreath population.
9	Mountain Gate	Not available	Not available	N/A	Private (Mountain Gate Quarry)	No determination of specific threats can be assessed. Near an active gravel quarry. Threats from invasive species is assumed due to the prevalence of Himalayan blackberry throughout the area.
10	Cove Creek/South of Cove Creek	1.33*	1000s	2006	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam. Considered 2 populations.
11	Ripgut Creek	0.18*	100	2003	USFS-Shasta-Trinity National Forest	
12	Stein Creek	≤42.15^+	716 to "thousands"	2010; 2011–2012	USFS-Shasta-Trinity National Forest, and Private (SPI)	Inundation from the project to raise the height of Shasta Dam. Extent of population may be less than 42.15 acres. Timberland management activities occurred within the population historically and during 2012-2015. 716 average ramet population size in 2011-2012. Includes former CNDDB element occurrence #13.
13	N/A					Subsumed into CNDDB element occurrence #12.
14	Waters Gulch	10.88*	20,100	2011–2013	USFS-Shasta-Trinity National Forest	Trail maintenance; Himalayan blackberry and Scotch broom occur in the population.
15	Keluche Creek	0.15*	500–1000	2003	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.

CNDDB Element Occurrence #	Population Name	Size (acres)	Estimated Population Size (Ramets)**	Year(s) of Population Estimate(s)**	Ownership	Notable Threats/Notes
16	Blue Ridge	1.17*	4585	2011–2013	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam; Himalayan blackberry present in the population. Considered 3 populations.
17	Flat Creek	2.67*	1000s	2007	USFS-Shasta-Trinity National Forest	
18	Brock Creek	1.38*	100+	2004	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
19	Stein West	4.92*	1000s	2006	USFS-Shasta-Trinity National Forest	
20	Shasta Caverns	0.08*	<100	2007	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
21	Jones Valley	0.34*	3878	2011–2013	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam; Himalayan blackberry occurs within and near the population.
22	Manzanita Hill	0.69‡	500–1000	2012, 2019	Private – SPI	Plants were outside of the timber harvest unit and are protected within an SPI Habitat Retention Area (HRA) and a Watercourse and Lake Protection Zone (WLPZ). Himalayan blackberry present in the population.
23	McCandless Gulch	18.8*	5000–7100	2012, 2014	Private – SPI	Timber harvest activities occurred along the edge of the population in 2014-2015. Himalayan blackberry present.

CNDDB Element Occurrence #	Population Name	Size (acres)	Estimated Population Size (Ramets)**	Year(s) of Population Estimate(s)**	Ownership	Notable Threats/Notes
24	East of Stein Creek	0.01	20–30	2015	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam. Considered part of the Stein Creek population (element occurrence #12) (Lindstrand pers. comm. 2020, 2021)
25	North of Marble Creek	1.37*	1700–2275	2014	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam. Considered 3 populations.
26	Allie Cove	0.04*	150–200	2015	USFS-Shasta-Trinity National Forest	
27	Bear Canyon	1.0	1500–2000	2016	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
28	Roberts Canyon	0.75	300–400	2016	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.

CNDDB = California Natural Diversity Database

Note: Sometimes an element occurrence is subsumed within another element occurrence as additional information is collected, and this has occurred for Shasta snow-wreath. Thus, former element occurrences 4 and 13 are no longer separate entities in the CNDDB, and there are currently occurrence numbers up to 28 (element occurrence numbers for a given species are never reassigned).

**Some CNDDB occurrences document population estimates for multiple years, and some estimates are from partial surveys or a portion of the occurrence. “Estimated Population Size (Ramets)” in this table is the most recent and complete estimate for an occurrence, and “Year(s) of Population Estimate(s)” corresponds with the estimate used in the table.

*Source: Detailed digital mapping data submitted to the CNDDB in shapefile format.

^Source: CNDDB shapefile. The CNDDB mapped polygons include a buffer. Therefore, the areas of the CNDDB polygons are larger than the actual extent of each population.

⁺Source: SLWRI EIS

‡Source: CNDDB description.

APPENDIX B: Comments from Affected and Interested Parties on the Petitioned Action

From: Wildlife Tribal Liaison
To: Burton, Cherilyn@Wildlife
Subject: FW: Shasta Snow-Wreath
Date: Monday, July 20, 2020 1:56:41 PM

Hi Cherilyn, see below for your records.

--
Nathan Voegeli
Attorney and Tribal Liaison
California Department of Fish and Wildlife
916-651-7653 office
916-698-6916 cell

From: John Hayward <cybersonnyhayward@gmail.com>
Sent: Monday, July 20, 2020 12:03 PM
To: Wildlife Tribal Liaison <tribal.liaison@wildlife.ca.gov>
Subject: Shasta Snow-Wreath

Att: Nathan Voegeli,

The Nor-Rel-Muk Wintu Nation has no concern with this project as it is not in our aboriginal territory. Thank you for contacting us.

Sincerely,
John (Sonny) Hayward
Tribal Chair
cybersonnyhayward@gmail.com
(530) 410-1125

From:	Len Lindstrand
To:	Burton, Cherilyn@Wildlife
Subject:	Neviusia cliftonii information for Status Review
Date:	Tuesday, July 21, 2020 3:49:02 PM
Attachments:	image001.png snow_wreath_alternative_impacts_2014 FEIS.pdf NECL listing petition_LL3 comments.pdf NECL occurrence names.kmz NECL occurrence rankings_CNDDB & LL3.pdf NECL occurrences summary & threats_CNDDB.pdf NECL occurrences summary & threats_LL3.pdf

Hi Cherlyn,

Attached please find summary information I prepared to assist your *Neviusia cliftonii* status review. First, I have included a kmz providing occurrence locations and names to help establish where these populations are located geographically and to serve as reference. Those names correspond with the tables I've included and the CNDDB occurrences. The three attached tables (1) summarize the CNDDB occurrence rankings per the CNDDB and include updates from myself, (2) provide a threats summary per the CNDDB with my comments, and (3) provide an independent threats assessment completed by myself.

Regarding the Bureau of Reclamation Shasta Dam Enlargement project, I am still trying to obtain and refine some survey data, but wanted to get you some information for initial review as I know your deadline is approaching. For now, I have attached the snow-wreath impact section for the Shasta Dam Enlargement project from the Bureau of Reclamation 2014 FEIS. When we have a chance to discuss, I can further explain the nuances behind the status of the snow-wreath impact analysis for the project, as additional information has not been released. Briefly, at the time of the 2014 FEIS there were 24 known occurrences totaling approximately 270 acres; the Shasta Dam project would impact approximately 2.6 acres at 11 of those occurrences; 13 occurrences would have no impact. That data is included in the attached summary table as presented in the FEIS (CP-3 is the 18.5-ft. raise). Since then, 7 (or 9 depending on lumping/splitting) additional occurrences were found totaling approximately 5 acres. The FEIS or supporting documentation was never updated. An update was completed for a CEQA document prepared for the project, but that document has not been released, per Court Order. Currently, there are 31 (or 33, depending on splitting/lumping) occurrences totaling approximately 275 acres; my estimates suggest the Shasta Dam project would impact approximately 3 acres at 14 of those occurrences; 17 (using the 31 occurrences I summarized for you) would have no impact. That's about 1.1 percent of all snow-wreath. The 2014 FEIS tables contain most of that information and I can describe the remainder.

Finally, I also attached a pdf copy of the listing petition with comments.

I realize this is a lot of information and I am more that happy to discuss with you on the phone to better explain all these components. Please feel free to contact me with any questions or

comments.

Thank you,

Len

Len Lindstrand III, CWB®
Terrestrial and Aquatic Biologist
Botany Program Manager

Sierra Pacific Industries
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Redding, CA 96049-6014

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Summary of *Neviusia cliftonii* occurrences with CNDDB[1] ranks and threats; and a threats assessment.

Population	CNDDB Element Occurrence	Description	Ownership	Occurrence Rank (CNDDB)	Potential Threats (per CNDDB record)	Threat Assessment
Cedar Creek	1	Type locality. Large population on a limestone outcrop upslope from a perennial creek. Site is within a CalTrans/CDFW Conservation Easement.	CalTrans/CDFW	Unknown	Mining, fires.	The occurrence is within a permanent CalTrans/CDFW Conservation Easement. Mining would not occur at this population. Fire is a potential threat given the proximity to a transmission line corridor and HWY 299E; however, the Ellery Creek study demonstrates fire is a low-degree threat.
Squaw Creek	2	Paratype locality. Large population located on a forested slope below a large limestone outcrop. The southwestern-most portion of the population occurs in a forest stand subject to historical timber harvest. The easternmost portion is within the northwestern edge of the USFS Devils-Rock Hosselkus Research Natural Area.	USFS, Private	Unknown	None listed.	N/A
Ellery Creek (includes small subpopulation near campground)	3 (includes former EO#4)	Paratype locality. Large population located on a forested slope and limestone outcrops upslope from a perennial stream. The occurrence also includes a very small disjunct subpopulation located near the USFS Ellery Creek Campground. The entire main occurrence burned during the 2018 Hirz Fire and responded with dense vegetative resprouting. The small subpopulation located near the campground did not burn.	USFS	Excellent	Non-native species (Himalayan blackberry and Scotch broom).	Himalayan blackberry occurs along the Ellery Creek drainage near Gillman Road and adjacent to the lower portion of the *Neviusia* population. Scotch broom also occurs nearby along the road and at the Ellery Creek Campground. Most of the population is currently located upslope from the non-native species, and these species didn't appear to spread due to the 2018 Hirz Fire.
South of Ellery Creek	4 (former EO#, CNDDB currently includes with EO#3)	Large population located on a forested slope and among limestone outcrops upslope from a perennial stream. Most of the occurrence burned during the 2018 Hirz Fire and responded with dense vegetative resprouting.	USFS	Excellent	Non-native species (Himalayan blackberry and Scotch broom).	Himalayan blackberry occurs along the unnamed creek drainage near Gillman Road and adjacent to the lower portion of the *Neviusia* population. Scotch broom also occurs nearby along the road. Most of the population is currently located upslope from the non-native species, and these species didn't appear to spread due to the 2018 Hirz Fire.
Curl Creek	5	Large population consisting of two distinct polygons along a perennial stream and limestone outcrops, and a third on a forested slope among limestone outcrops.	USFS	Excellent	None listed.	N/A
Campbell Creek	6	Large population along a perennial stream and adjacent forest slope.	USFS	Good	Logging, road maintenance, raised lake level, noxious weed invasion.	Logging does not occur on USFS lands in the Shasta-Trinity NRA. There is no road near the population; an old jeep trail occurs upslope opposite the occurrence and is no longer used. A small segment of the downstream-most portion of the population near the current lake level would be flooded. Most of the population is above the proposed inundation zone and would not be impacted. Himalayan blackberry occurs near the population.
Low Pass	7	Large population located along a perennial stream drainage and adjacent forested slope with limestone outcrops. A historic road (now trail) was built through portions of the population located along the stream. Within the USFS Devils Rock-Hosselkus Research Natural Area.	USFS	Excellent	Occurrence near a jeep trail.	The jeep trail is a historic two-track road now located within the Hosselkuss RNA. Functionally the road is currently a foot trail. The area is very remote and receives little visitation or any "road" traffic.
Bear Gulch	8	Moderate-sized population occurring on a forested slope above a perennial creek floodplain, with scattered small patches further upslope. The population was subject to historic timber harvest.	Private	Good	None listed.	N/A
Mountain Gate	9	Moderate-sized population occurring in a forested slope adjacent to an intermittent drainage. Near an active gravel quarry.	Private	Unknown	None listed.	N/A
Cove Creek	10	Moderately-sized population located along an intermittent stream. The population consists of six distinct patches scattered within the creek drainage.	USFS	Good	None listed.	N/A

South of Cove Creek	10	Small population located along an intermittent stream. The population consists of four distinct patches scattered within the creek drainage.	USFS	Good	None listed.	N/A
Ripgut Creek	11	Small population located on a forested slope along a perennial stream.	USFS	Good	None listed.	N/A
Stein Creek (includes Stein Creek inlet subpopulations)	12 (CNDDB includes former EO#13); population as defined here includes EO#24.	Large population scattered throughout a perennial stream watershed. There are four scattered small sub-populations on forested slopes above the Stein Creek inlet of Shasta Lake, while most of the population occurs upstream from the Stein Creek/Shasta Lake confluence along the mainstem stream and tributaries. The lower portion of the watershed is USFS ownership. The upper portion of the watershed is privately owned. Habitats in the upper portion of the population were subject to historic and recent timber harvest activities. Recent timber harvest activities impacted small amounts of plants due to road construction; other impacts were avoided by relocating roads and establishing a Habitat Retention Area around a portion of the population located near a harvest unit.	USFS, Private	Good	Timber harvest on portions of occurrence on private land.	Some *Neviusia* shrubs in the upper portion of the population were subject to impacts relating to recent (2012-2015) timber harvest activities (road crossings). Other impacts were avoided by relocating roads and establishing a Habitat Retention Area around a portion of the population located near a harvest unit. These activities were regulated by the CFPRs. Overall, the impacts were a small portion of the population.
Waters Gulch	14	Expansive population consisting of two large and two smaller patches. The USFS Waters Gulch Trail was constructed through the lower patch (downstream-most) prior to the species discovery. Plants along the trail have likely been subject to occasional trail maintenance; and previous grubbing associated with the trail having been used as a break for a prescribed fire. Portions of the upper-most patch are near Packers Bay Road and among an invasive broom population.	USFS	Good	Previous trail construction, invasive species (Scotch broom).	The portion of the population located adjacent to the Waters Gulch Trail may be subject to occasional trail maintenance, but that impact is minor, can be managed, and affects a small proportion of the population. Plants subject to maintenance have also been observed resprouting. Other portions of the population are subject to invasive species; however, the USFS has an active project in place designed to eliminate the broom population and aid the *Neviusia* population.
Keluche Creek	15	Small population located at the Keluche Creek confluence with Shasta Lake.	USFS	Good	None listed.	N/A
Blue Ridge (east)	16	Small population; one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge.	USFS	Good	None listed.	N/A
Blue Ridge (middle)	16	Small population; one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge. A historic dirt road cut through a portion of this population; *Neviusia* plants have regrown into the former road cuts.	USFS	Good	None listed.	N/A
Blue Ridge (west)	16	Moderate-sized population; one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge. A historic dirt road cut through a portion of this population; *Neviusia* plants have regrown into the former road cuts.	USFS	Good	None listed.	N/A
Flat Creek	17	Large population located in a riparian area and forest slope adjacent to Flat Creek.	USFS	Good	None listed.	N/A
Brock Creek	18	Moderate-sized population located on small limestone outcrops in a drainage tributary to the Brock Creek inlet of Shasta Lake.	USFS	Good	None listed.	N/A

Stein West	19	Large population located in a riparian area and forest slope adjacent to an unnamed drainage tributary to Shasta Lake.	USFS	Good	None listed.	N/A
Shasta Caverns (includes small subpopulation)	20	Small, contiguous population located on a forested slope upslope from a seasonal stream tributary to Shasta Lake. The occurrence also includes a very small disjunct subpopulation located near the existing Shasta Lake shoreline.	USFS	Good	None listed.	N/A
Jones Valley	21	One moderate-sized patch and two very small patches located in a seasonal drainage tributary to Shasta Lake. Several shrubs within a portion of this population were included in a USFS prescribed fire and subject to a light burn; these shrubs were observed resprouting the following season.	USFS	Good	None listed.	N/A
Manzanita Hill	22	Moderate-sized population located along a riparian area and adjacent forested slope in a drainage tributary to Cedar Creek.	Private	Good	Timber harvest unit.	Timberland management activities occurred near the population during 2014-2015. These activities were regulated by the CFPRs. The *Neviusia* population was avoided and protected in a Watercourse and Lake Protection Zone and SPI Habitat Retention Area.
McCandless Gulch	23	Large population located along riparian areas and adjacent forested slopes in a drainage tributary to Cedar Creek. The occurrence was subject to historic timber harvest throughout. A very small portion of the population was subject to accidental herbicide treatment during forest management activities, killing the exposed plants. *Neviusia* plants located adjacent are re-colonizing the sprayed area. The population is included in a long-term monitoring study being conducted by SPI.	Private	Excellent	Timber harvest, non-native species (Himalayan blackberry).	Timberland management activities occurred near the population during 2014-2015. These activities were regulated by the CFPRs. Most of the *Neviusia* population was avoided and protected in a SPI Habitat Retention Area. Following negotiations with CDFW, portions of the population were intended to be subject to limited logging activity and included in the monitoring effort. Very little (less than intended) logging activity occurred within the *Neviusia* population, and the monitoring is on-going. Himalayan blackberry is prevalent throughout the drainage.
North of Marble Creek 1	25	Moderate-sized population; one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	Good	None listed.	N/A
North of Marble Creek 2	25	Moderate-sized population; one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	Good	None listed.	N/A
North of Marble Creek 3	25	Small population; one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	Good	None listed.	N/A
Allie Cove	26	Small population occurring on a forested slope and limestone outcrop.	USFS	Good	None listed.	N/A
Bear Canyon	N/A	Large population located on a steep forested slope above Shasta Lake.	USFS	N/A	N/A	N/A
Roberts Canyon	N/A	Moderate-sized population located on a steep forested slope above Shasta Lake.	USFS	N/A	N/A	N/A

[1] July 2020 version.

Population	Summary	Ownership	Threat Assessment[1,2]	
			Current or Reasonably Foreseeable	Potential
Allie Cove	Small population occurring on a forested slope and limestone outcrop.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	**Threat(s):** Climate change, wildfire. **Assessment:** Climate change. Low degree of threat. Climate change models suggest warmer and wetter conditions within the species range. This situation likely won't affect *Neviusia* populations; however, these conditions may also be suitable for invasive species. Wildfire. Low degree of threat. While fire may impact *Neviusia* populations, the Ellery Creek study demonstrates affects from even high severity fire are temporary, very short-term, and may stimulate population growth. Fire could promote invasive species growth in some situations.
Bear Canyon	Large population located on a steep forested slope above Shasta Lake.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Bear Gulch	Moderate-sized population occurring on a forested slope above a perennial creek floodplain, with scattered patches further upslope. The population was subject to historic timber harvest. Most of the population is within a parcel including portions of Section 29, which is owned by a construction company (Stimpel-Wiebelhaus). Stimpel-Wiebelhaus owns the parcel (which includes the Section 29 portion of the occurrence) because it includes a limestone quarry located approx. 0.5-mi. northeast in a separate sub-watershed; the portion of the parcel including the Shasta snow-wreath population is not part of quarry operations. The remainder of the population extends into Section 30, which is owned by Sierra Pacific Land & Timber Company (SPL&T).	Private (Stimpel-Wiebelhaus and SPL&T)	**Threat(s):** Timberland management activities, invasive species, development. **Assessment:** Timberland management activities. Low degree of threat. This threat most likely applies to the portion of the population in Section 30, and only a small proportion of the population occurs in this Section. Timber harvest activities would be subject to the CFPRs, which would afford species protection measures. Section 29 contains commercial timber, and has been subject to historic timber harvest; however, given the landowner the likelihood of this activity is low. If timber harvest activities occurred, they would also be subject to the CFPRs. Invasive species. Low to moderate degree of threat. Himalayan blackberry is prevalent within the Bear Gulch drainage and vicinity. Development. Low degree of threat. Included here because the parcel is privately owned, this portion of the parcel (i.e., near the *Neviusia* occurrence) is a former residence, and is functionally separated from the limestone quarry.	See above.
Blue Ridge (east)	Small population, and one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Blue Ridge (middle)	Small population, and one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge. A historic dirt road cut through a portion of this population; *Neviusia* plants have regrown into the former road cuts.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.

Blue Ridge (west)	Moderate-sized population, and one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge. A historic dirt road cut through a portion of this population; *Neviusia* plants have regrown into the former road cuts.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Brock Creek	Moderate-sized population located on small limestone outcrops in a drainage tributary to the Brock Creek inlet of Shasta Lake.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Campbell Creek	Large population along a perennial stream and adjacent forest slope.	USFS	**Threat(s):** Invasive species. **Assessment:** Low to moderate degree of threat. Himalayan blackberry occurs near the downstream-most portion of the *Neviusia* population and could potentially spread. Overall, the threats to this site are low, as the site is remote and within a USFS NRA.	See above.
Cedar Creek	Type locality. Large population on limestone outcrop upslope from a perennial creek. Site is within a CalTrans/CDFW Conservation Easement.	CalTrans/CDFW	**Threat(s):** Invasive species, wildfire. **Assessment:** Invasive species. Low degree of threat. Himalayan blackberry occurs near the *Neviusia* population and vicinity. Wildfire. Low degree of threat. A fire burned at or near the site during 2014 under the electronic transmission lines that cross near the occurrence. The occurrence has been observed extant each year since the fire. While fire may impact *Neviusia* populations, the Ellery Creek study demonstrates affects from even high severity fire are temporary, very short-term, and may stimulate population growth. Fire could promote invasive species growth in some situations.	See above.
Cove Creek	Moderately-sized population located along an intermittent stream. The population consists of six distinct patches scattered within the creek drainage.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Curl Creek	Large population consisting of two distinct polygons along a perennial stream and limestone outcrops, and a third on a forested slope among limestone outcrops.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Ellery Creek (includes small subpopulation)	Paratype locality. Large population located on a forested slope and limestone outcrops upslope from a perennial stream. The occurrence also includes a very small disjunct sub-population located near the USFS Ellery Creek Campground. The entire main occurrence burned during the 2018 Hirz Fire and responded with dense vegetative resprouting. The small subpopulation located near the campground did not burn.	USFS	**Threat(s):** Invasive species. **Assessment:** Low to moderate degree of threat. Himalayan blackberry occurs near the *Neviusia* population and vicinity; broom also occurs in the vicinity.	See above.
Flat Creek	Large population located in a riparian area and forest slope adjacent to Flat Creek.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Jones Valley	One moderate-sized patch and two very small patches located in a seasonal drainage tributary to Shasta Lake. Several shrubs within a portion of this population were included in a USFS prescribed fire and subject to a light burn; these shrubs were observed resprouting the following season.	USFS	**Threat(s):** Invasive species. **Assessment:** Low to moderate degree of threat. Himalayan blackberry occurs within portions of the *Neviusia* population and in the vicinity.	See above.
Keluche Creek	Small population located at the Keluche Creek confluence with Shasta Lake.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.

Low Pass	Large population located along a perennial stream drainage and adjacent forested slope with limestone outcrops. A historic road (now trail) was built through portions of the population located along the stream. Within the USFS Devils Rock-Hosselkus Research Natural Area.	USFS	**Threat(s):** Invasive species. **Assessment:** Low to moderate degree of threat. Himalayan blackberry occurs within portions of the *Neviusia* population, particularly the westernmost portion, and throughout the vicinity. Lack of disturbance and moisture likely limits the expansion into much of the population; however, the portion of the occurrence in the low areas near the creek drainage are vulnerable.	See above.
Manzanita Hill	Moderate-sized population located along a riparian area and adjacent forested slope in a drainage tributary to Cedar Creek.	Private (SPL&T)	**Threat(s):** Timberland management activities, invasive species. **Assessment:** Timberland management activities. Low degree of threat. Timberland management activities occurred near the population during 2014-2015. These activities were regulated by the CFPRs. The Neviusia population was avoided and protected in a Watercourse and Lake Protection Zone and SPI Habitat Retention Area. Invasive species. Moderate degree of threat. Himalayan blackberry occurs within the unnamed drainage adjacent to the site and is prevalent in the vicinity.	See above.
McCandless Gulch	Large population located along riparian areas and adjacent forested slopes in a drainage tributary to Cedar Creek. The occurrence was subject to historic timber harvest throughout. A very small portion of the population was subject to accidental herbicide treatment during forest management activities, killing the exposed plants. *Neviusia* plants located adjacent are re-colonizing the sprayed area. The population is included in a long-term monitoring study being conducted by SPI.	Private (SPL&T)	**Threat(s):** Timberland management activities, invasive species. **Assessment:** Timberland management activities. Low to degree of threat. Timberland management activities occurred throughout the population historically, and near the population during 2014-2015. The recent activities were regulated by the CFPRs. Most of the *Neviusia* population was avoided and protected in a SPI Habitat Retention Area. Following negotiations with CDFW, portions of the population were intended to be subject to limited logging activity and included in the monitoring effort. Very little (less than intended) logging activity occurred within the Neviusia population, and the monitoring is on-going. Future timberland management activities would be regulated by the CFPRs. Invasive species. Low to moderate degree of threat. Himalayan blackberry is prevalent throughout the McCandless Gulch drainage.	See above.
Mountain Gate	Moderate-sized population occurring in a forested slope adjacent to an intermittent drainage. Near an active gravel quarry.	Private (Mt. Gate Quarry)	**Threat(s):** Mining activities, invasive species. **Assessment:** Mining activities. Low to moderate degree of threat. Mining activities are assumed reasonably foreseeable based on geographic location and ownership. While within a mine property, the *Neviusia* site is outside current operations. Any mine expansion would be regulated by numerous local and state requirements, including CEQA and SMARA. Invasive species. Moderate degree of threat (assumed). Himalayan blackberry is prevalent throughout the area.	See above.
North of Marble Creek 1	Moderate-sized population, and one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
North of Marble Creek 2	Moderate-sized population, and one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.

North of Marble Creek 3	Small population, and one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Ripgut Creek	Small population located on a forested slope along a perennial stream.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Roberts Canyon	Moderate-sized population located on a steep forested slope above Shasta Lake.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
Shasta Caverns (includes small subpopulation)	Small, contiguous population located on a forested slope upslope from a seasonal stream tributary to Shasta Lake. The occurrence also includes a very small disjunct sub-population located near the existing Shasta Lake shoreline.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
South of Cove Creek	Small population located along an intermittent stream. The population consists of four distinct patches scattered within the creek drainage.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.
South of Ellery Creek	Large population located on a forested slope and among limestone outcrops upslope from a perennial stream. Most of the occurrence burned during the 2018 Hirz Fire and responded with dense vegetative resprouting.	USFS	**Threat(s):** Invasive species. **Assessment:** Low to moderate degree of threat. Himalayan blackberry occurs near the *Neviusia* population and vicinity; broom also occurs in the vicinity.	See above.
Squaw Creek	Paratype locality. Large population located on a forested slope below a large limestone outcrop. The southwestern-most portion of the population occurs in a forest stand subject to historical timber harvest. USFS ownership; the easternmost portion is within the northwestern edge of the USFS Devils-Rock Hosselkus Research Natural Area.	USFS, Private	**Threat(s):** Invasive species. **Assessment:** Low to moderate degree of threat. Himalayan blackberry occurs near the *Neviusia* population and is prevalent in the vicinity.	See above.
Stein Creek (includes Stein Creek inlet subpopulations)	Large population scattered throughout a perennial stream watershed. There are four scattered small sub-populations on forested slopes above the Stein Creek inlet of Shasta Lake, while most of the population occurs upstream from the Stein Creek/Shasta Lake confluence along the mainstem stream and tributaries. The lower portion of the watershed is USFS ownership. The upper portion of the watershed is privately owned. Habitats in the upper portion of the population were subject to historic and recent timber harvest activities. Recent timber harvest activities impacted small amounts of plants due to road construction; other impacts were avoided by relocating roads and establishing a Habitat Retention Area around a portion of the population located near a harvest unit.	USFS, Private (SPL&T)	**Threat(s):** Timberland management activities, invasive species. **Assessment:** Timberland management activities. Applies to the portions of the occurrence located on private lands. Low degree of threat. Timberland management activities occurred throughout this portion of the population historically, and near portions of the population during 2012-2015. The recent activities were regulated by the CFPRs. Some *Neviusia* shrubs were subject to impacts relating to road crossings. Other impacts were avoided by relocating roads and establishing a Habitat Retention Area around a portion of the population located near a harvest unit. Overall, the impacts were a small portion of the population. The lower portion of the population is remote and within a USFS NRA. Invasive species. Low to moderate degree of threat. Himalayan blackberry occurs throughout the Stein Creek watershed.	See above.
Stein West	Large population located in a riparian area and forest slope adjacent to an unnamed drainage tributary to Shasta Lake.	USFS	**Threat(s):** None. **Assessment:** The site is remote and within a USFS NRA.	See above.

Waters Gulch	Expansive population consisting of two large and two smaller patches. The USFS Waters Gulch Trail was constructed through the lower patch (downstream-most) prior to the species discovery. Plants along the trail have likely been subject to occasional trail maintenance; and subject to grubbing associated with the trail having been used as a break for a prescribed fire. Portions of the upper-most patch are near Packers Bay Road and among an invasive broom population.	USFS	**Threat(s):** Trail maintenance, invasive species. **Assessment:** Trail maintenance. Low degree of threat. The portion of the population located adjacent to the Waters Gulch Trail may be subject to occasional trail maintenance, but that impact is minor, can be managed, and affects a small proportion of the population. Plants subject to maintenance have also been observed resprouting. Invasive species. Low to moderate degree of threat. Portions of the population are subject to Himalayan blackberry and broom; however, the USFS has an active project in place designed to eliminate the broom population and aid the Neviusia population.	See above.

[1]Threats defined as any action or condition known to, or is reasonably likely to, negatively affect *Neviusia cliftonii*, including direct impact on individuals and alterations of their habitat or required resources.

Current or reasonably foreseeable = a threat currently present or could be in the near future.

Potential = Something generally considered a threat regionally; these may or may not occur, and may or may not have negative effects.

[2] Potential threats to these populations related to the proposed Shasta Dam enlargement project are summarized in a separate analysis.

Population	CNDDB Element Occurrence	Description	Ownership	Occurrence Rank (CNDDB)[1]	Occurrence Rank (LL3)[2]
Cedar Creek	1	Type locality. Large population on a limestone outcrop upslope from a perennial creek. Site is within a CalTrans/CDFW Conservation Easement.	CalTrans/CDFW	Unknown	Excellent
Squaw Creek	2	Paratype locality. Large population located on a forested slope below a large limestone outcrop. The southwestern-most portion of the population occurs in a forest stand subject to historical timber harvest. The easternmost portion is within the northwestern edge of the USFS Devils-Rock Hosselkus Research Natural Area.	USFS, Private	Unknown	Excellent
Ellery Creek (includes small subpopulation near campground)	3 (includes former EO#4)	Paratype locality. Large population located on a forested slope and limestone outcrops upslope from a perennial stream. The occurrence also includes a very small disjunct subpopulation located near the USFS Ellery Creek Campground. The entire main occurrence burned during the 2018 Hirz Fire and responded with dense vegetative resprouting. The small subpopulation located near the campground did not burn.	USFS	Excellent	Excellent
South of Ellery Creek	4 (former EO#, CNDDB currently includes with EO#3)	Large population located on a forested slope and among limestone outcrops upslope from a perennial stream. Most of the occurrence burned during the 2018 Hirz Fire and responded with dense vegetative resprouting.	USFS	Excellent	Excellent
Curl Creek	5	Large population consisting of two distinct polygons along a perennial stream and limestone outcrops, and a third on a forested slope among limestone outcrops.	USFS	Excellent	Excellent
Campbell Creek	6	Large population along a perennial stream and adjacent forest slope.	USFS	Good	Excellent
Low Pass	7	Large population located along a perennial stream drainage and adjacent forested slope with limestone outcrops. A historic road (now trail) was built through portions of the population located along the stream. Within the USFS Devils Rock-Hosselkus Research Natural Area.	USFS	Excellent	Excellent
Bear Gulch	8	Moderate-sized population occurring on a forested slope above a perennial creek floodplain, with scattered small patches further upslope. The population was subject to historic timber harvest.	Private	Good	Good
Mountain Gate	9	Moderate-sized population occurring in a forested slope adjacent to an intermittent drainage. Near an active gravel quarry.	Private	Unknown	Fair
Cove Creek	10	Moderately-sized population located along an intermittent stream. The population consists of six distinct patches scattered within the creek drainage.	USFS	Good	Good
South of Cove Creek	10	Small population located along an intermittent stream. The population consists of four distinct patches scattered within the creek drainage.	USFS	Good	Good
Ripgut Creek	11	Small population located on a forested slope along a perennial stream.	USFS	Good	Good
Stein Creek (includes Stein Creek inlet subpopulations)	12 (CNDDB includes former EO#13); population as defined here includes EO#24.	Large population scattered throughout a perennial stream watershed. There are four scattered small sub-populations on forested slopes above the Stein Creek inlet of Shasta Lake, while most of the population occurs upstream from the Stein Creek/Shasta Lake confluence along the mainstem stream and tributaries. The lower portion of the watershed is USFS ownership. The upper portion of the watershed is privately owned. Habitats in the upper portion of the population were subject to historic and recent timber harvest activities. Recent timber harvest activities impacted small amounts of plants due to road construction; other impacts were avoided by relocating roads and establishing a Habitat Retention Area around a portion of the population located near a harvest unit.	USFS, Private	Good	Good
Waters Gulch	14	Expansive population consisting of two large and two smaller patches. The USFS Waters Gulch Trail was constructed through the lower patch (downstream-most) prior to the species discovery. Plants along the trail have likely been subject to occasional trail maintenance; and previous grubbing associated with the trail having been used as a break for a prescribed fire. Portions of the upper-most patch are near Packers Bay Road and among an invasive broom population.	USFS	Good	Good
Keluche Creek	15	Small population located at the Keluche Creek confluence with Shasta Lake.	USFS	Good	Good
Blue Ridge (east)	16	Small population; one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge.	USFS	Good	Good

Blue Ridge (middle)	16	Small population; one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge. A historic dirt road cut through a portion of this population; *Neviusia* plants have regrown into the former road cuts.	USFS	Good	Good
Blue Ridge (west)	16	Moderate-sized population; one of three proximate, distinct populations located on forested slopes and drainages above Shasta Lake at the north end of Blue Ridge. A historic dirt road cut through a portion of this population; *Neviusia* plants have regrown into the former road cuts.	USFS	Good	Good
Flat Creek	17	Large population located in a riparian area and forest slope adjacent to Flat Creek.	USFS	Good	Excellent
Brock Creek	18	Moderate-sized population located on small limestone outcrops in a drainage tributary to the Brock Creek inlet of Shasta Lake.	USFS	Good	Good
Stein West	19	Large population located in a riparian area and forest slope adjacent to an unnamed drainage tributary to Shasta Lake.	USFS	Good	Excellent
Shasta Caverns (includes small subpopulation)	20	Small, contiguous population located on a forested slope upslope from a seasonal stream tributary to Shasta Lake. The occurrence also includes a very small disjunct subpopulation located near the existing Shasta Lake shoreline.	USFS	Good	Good
Jones Valley	21	One moderate-sized patch and two very small patches located in a seasonal drainage tributary to Shasta Lake. Several shrubs within a portion of this population were included in a USFS prescribed fire and subject to a light burn; these shrubs were observed resprouting the following season.	USFS	Good	Good
Manzanita Hill	22	Moderate-sized population located along a riparian area and adjacent forested slope in a drainage tributary to Cedar Creek.	Private	Good	Good
McCandless Gulch	23	Large population located along riparian areas and adjacent forested slopes in a drainage tributary to Cedar Creek. The occurrence was subject to historic timber harvest throughout. A very small portion of the population was subject to accidental herbicide treatment during forest management activities, killing the exposed plants. *Neviusia* plants located adjacent are re-colonizing the sprayed area. The population is included in a long-term monitoring study being conducted by SPI.	Private	Excellent	Excellent
North of Marble Creek 1	25	Moderate-sized population; one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	Good	Good
North of Marble Creek 2	25	Moderate-sized population; one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	Good	Good
North of Marble Creek 3	25	Small population; one of three proximate, distinct populations located north of Marble Creek on a forested slope among the base of limestone outcrops.	USFS	Good	Good
Allie Cove	26	Small population occurring on a forested slope and limestone outcrop.	USFS	Good	Good
Bear Canyon	N/A	Large population located on a steep forested slope above Shasta Lake.	USFS	N/A	Excellent
Roberts Canyon	N/A	Moderate-sized population located on a steep forested slope above Shasta Lake.	USFS	N/A	Good

[1] July 2020 version

[2]Occurrence ranking combines size, health, location, and potential threats.

Impact Bot-2 (CP1): Loss of MSCS Covered Species

Inundation caused by a 6.5-foot dam raise would affect all or portions of nine Shasta snow-wreath populations. These nine populations represent 38 percent of all known Shasta snow-wreath populations and encompass approximately 79 acres. Flooding impacts under CP1 would result in the loss of approximately 1.5 acres, or approximately 2 percent of these nine Shasta snow-wreath populations. The greatest proportional impacts to these populations occur at the Blue Ridge West, Brock Creek, Cove Creek, Keluche Creek, and Shasta Caverns populations. Table 12-14 provides a detailed summary of impacts to Shasta snow-wreath under CP1. Mitigation measures for impacts to Shasta snow-wreath populations are presented in Section 12.3.5, "Mitigation Measures."

Table 12-14. Summary of Impacts to Shasta Snow-wreath Populations Adjacent to Shasta Lake Under CP1

Population	Location	Size (Acres)	CP1 Impact (Acres)	Percent Total Impact to Population	Comments
Blue Ridge (west)	Main Body	1.11	0.470	42%	Lower portion of population would be flooded.
Blue Ridge (east)	Main Body	0.03	0	0%	No impact under CP1.
Brock Creek	Pit River Arm	1.38	0.487	35%	Lower portion of population would be flooded.
Campbell Creek	McCloud River Arm	1.90	0.002	<1%	Small area at the downstream portion of the population would be flooded.
Cove Creek	Main Body	1.87	0.264	14%	Lower portion of population would be flooded.
Ellery Creek	McCloud River Arm	28.65	0.031	<1%	The entire very small disjunct sub-population located near Ellery Creek Campground would be flooded.
Jones Valley	Main Body	0.33	0	0%	No Impact under CP1.
Keluche Creek	McCloud River Arm	0.15	0.085	56%	More than half of the population would be flooded.
Shasta Caverns	McCloud River Arm	0.08	0.018	21%	Lower portion of population would be flooded.
South of Cove Creek	Main Body	1.39	0.143	10%	Lower portion of population would be flooded.
Stein Creek	Pit River Arm	42.15	0.023	<1%	Lower portion of population would be flooded.

Key:
% = percent
< = less than
CP = Comprehensive Plan

Impact Bot-2 (CP2): Loss of MSCS Covered Species Implementation of the project would result in the loss of MSCS covered species because of inundation, vegetation removal, or construction activities. Therefore, this impact would be

significant. Impacts related to dam construction and vegetation clearing within the relocation areas would be similar to but greater than CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would affect all or portions of ten Shasta snow-wreath populations. These ten populations represent 42 percent of all known Shasta snow-wreath populations and encompass approximately 79 acres. Flooding impacts under CP2 would result in the loss of approximately 1.8 acres, or approximately 2 percent of these ten Shasta snow-wreath populations. The greatest proportional impacts to these populations occur at the Blue Ridge West, Brock Creek, Cove Creek, Keluche Creek, and Shasta Caverns populations. Table 12-19 provides a detailed summary of impacts to Shasta snow-wreath under CP2. Mitigation measures for impacts to Shasta snow-wreath populations are presented in Section 12.3.5, "Mitigation Measures."

The impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Table 12-19. Summary of Impacts to Shasta Snow-Wreath Populations Adjacent to Shasta Lake Under CP2

Population	Location	Size (Acres)	CP2 Impact (Acres)	Percent Total Impact to Population	Comments
Blue Ridge (west)	Main Body	1.11	0.594	53%	More than half of the population would be flooded.
Blue Ridge (east)	Main Body	0.03	0	0%	No impact under CP2.
Brock Creek	Pit River Arm	1.38	0.545	39%	Lower portion of population would be flooded.
Campbell Creek	McCloud River Arm	1.90	0.002	<1%	Small area at the downstream portion of the population would be flooded.
Cove Creek	Main Body	1.87	0.337	18%	Lower portion of population would be flooded.
Ellery Creek	McCloud River Arm	28.65	0.038	<1%	The entire very small disjunct sub-population located near Ellery Creek Campground would be flooded.
Jones Valley	Main Body	0.33	0.003	1%	Small area at lower portion or population would be flooded.
Keluche Creek	McCloud River Arm	0.15	0.112	73%	Nearly ¾ of the population would be flooded.
Shasta Caverns	McCloud River Arm	0.08	0.026	31%	Lower portion of population would be flooded.
South of Cove Creek	Main Body	1.39	0.149	11%	Lower portion of population would be flooded.
Stein Creek	Pit River Arm	42.15	0.028	<1%	Lower portion of population would be flooded.

Key:
% = percent
< = less than
CP = Comprehensive Plan

Impact Bot-2 (CP3): Loss of MSCS Covered Species Implementation of the project would result in the loss of MSCS covered species because of inundation, vegetation removal, or construction activities. Therefore, this impact would be significant. Impacts related to dam construction and vegetation clearing within the relocation areas would be similar to but greater than CP2. However, inundation caused by an 18.5-foot raise of Shasta Dam would affect all or portions of eleven Shasta snow-wreath populations. These eleven populations represent 46 percent of all known Shasta snow-wreath populations and encompass approximately 79 acres. Flooding impacts under CP2 would result in the loss of approximately 2.6 acres, or approximately 3 percent of these eleven Shasta snow-wreath populations. The greatest proportional impacts to these populations occur at the Blue Ridge West, Brock Creek, Cove Creek, Keluche Creek, and Shasta Caverns populations. Table 12-22 provides a detailed summary of impacts to Shasta snow-wreath under CP3. Mitigation measures for impacts to Shasta snow-wreath populations are presented in Section 12.3.5, "Mitigation Measures."

Table 12-22. Summary of Impacts to Shasta Snow-Wreath Populations Adjacent to Shasta Lake Under CP3

Population	Location	Size (Acres)	CP3 Impact (Acres)	Percent Total Impact to Population	Comments
Blue Ridge (west)	Main Body	1.11	0.750	68%	Lower portion of population would be flooded.
Blue Ridge (east)	Main Body	0.03	0.002	7%	Lower portion of population would be flooded.
Brock Creek	Pit River Arm	1.38	0.634	46%	Nearly half of the population would be flooded.
Campbell Creek	McCloud River Arm	1.90	0.036	2%	Small area at the downstream portion of the population would be flooded.
Cove Creek	Main Body	1.87	0.401	21%	Lower portion of population would be flooded.
Ellery Creek	McCloud River Arm	28.65	0.047	<1%	The entire very small disjunct sub-population located near Ellery Creek Campground would be flooded.
Jones Valley	Main Body	0.33	0.015	4%	Nearly all of both small disjunct sub-populations at the lower portion of the population would be flooded.
Keluche Creek	McCloud River Arm	0.15	0.146	95%	Nearly all of the population would be flooded.
Shasta Caverns	McCloud River Arm	0.08	0.018	21%	Lower portion of population would be flooded.

Population	Location	Size (Acres)	CP3 Impact (Acres)	Percent Total Impact to Population	Comments
South of Cove Creek	Main Body	1.39	0.149	11%	Lower portion of population would be flooded.
Stein Creek	Pit River Arm	42.15	0.469	1%	Lower portion of population would be flooded.

Key:
% = percent
< = less than
CP = Comprehensive Plan

APPENDIX C: External Peer Review Invitation Letters and Comments from Peer Reviewers on the Shasta Snow-wreath Status Review Report

State of California – Natural Resources Agency
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GAVIN NEWSOM, Governor
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Date: 8/16/2021

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SUBJECT: STATUS REVIEW OF SHASTA SNOW-WREATH; CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW

Dear Julie Kierstead:

Thank you for agreeing to serve as a scientific peer reviewer of the California Department of Fish and Wildlife (Department) Status Review of Shasta Snow-wreath (*Neviusia cliftonii*) (Status Review). A draft of the Department's Status Review, dated August 16, 2021, is included with this letter. The Department seeks your expert analysis and input regarding the scientific validity of the Status Review and its assessment of the status of Shasta snow-wreath in California. The Department would appreciate receiving your peer review comments on or before September 10, 2021.

The Department seeks your scientific peer review as part of formal proceedings pending before the Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). The Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened (Fish & G. Code, § 2070). The Department serves in an advisory capacity during CESA listing proceedings, charged by the Fish and Game Code to provide a report to the Commission based on the best scientific information available indicating whether recommendations to list species are warranted and recommending actions for recovery of those species (Fish & G. Code, § 2074.6).

On September 30, 2019, the Commission received a petition to list Shasta snow-wreath as an endangered species under CESA. On May 1, 2020, the Commission published findings formally designating Shasta snow-wreath as a candidate species for endangered status under CESA while a status review was completed by the Department. Shasta snow-wreath is currently protected under CESA in California in that capacity.

The peer review draft of the Department's Status Review forwarded to you today reflects the Department's effort to identify and analyze the best scientific information available regarding the status of Shasta snow-wreath in California. At this time, the Department believes that the best available science indicates that listing the species as

threatened under CESA is warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code. Our expected recommendation to the Commission at this point may change following peer review input.

We ask you to focus your peer review on the best scientific information available regarding the status of Shasta snow-wreath in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA are particularly important (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A)) (i.e., present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) as well as whether the information indicates, in your opinion, that Shasta snow-wreath, although not currently faced with extinction, is likely to become an endangered species in the foreseeable future in the absence of protection by CESA. Please note that the Department releases this Status Review to you solely as part of the peer review process, and it is not yet public.

A PDF version of the Status Review is included with this letter. For ease of review, and so we may respond to your comments individually, please submit your comments in list form by page and line number. Please submit your comments electronically to Cherilyn Burton, Senior Environmental Scientist (Specialist) at cherilyn.burton@wildlife.ca.gov. Cherilyn Burton may also be reached at (916) 206-0411. If there is anything the Department can do to facilitate your review, please let us know.

Following receipt and consideration of peer review comments, the Department will prepare and submit its final Status Review and recommendation to the Commission. Your comments and the Department's response to each comment will be included in an appendix to the Department's Status Review. After a minimum 30-day public review period and prior to making their decision, the Commission will consider: the Department's recommendation to list Shasta snow-wreath, the Department's Status Review with peer reviewer comments, and public testimony received during a regularly scheduled Commission meeting.

Thank you again for your contribution to the Status Review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

DocuSigned by:
Jeff Drongesen
37E732799B3C452...

Jeff Drongesen, Branch Chief
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Enclosures

ec: California Department of Fish and Wildlife

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Julie A. Kierstead review comments 9/6/2021

page	line	comment
v	19	Add French broom (Genista monspessulana) to the list of invasive species. It is overwhelmingly present at Ellery Creek, though the CNDDB entry cites Scotch broom.
12	5	Add "or both" to the end of the sentence; the two explanations for low allelic variation are not mutually exclusive, as both could be happening.
12	15	Neviusia growth form and shreddy bark are similar to oceanspray and ninebark, so unless flowers are present, it is easy to mistake the twigs and leaves of Neviusia for these other plants that grow in similar habitats and are present within the range of N. cliftonii. The flowering season for Neviusia cliftonii is short, so the period of time when mistaken ID is likely is long.
13		you may want to insert photos of the twigs and bark if you can find some
14	28	Although the CNDDB EO 3 (Ellery Creek) entry for threat comments identifies Rubus discolor/armeniacus and Cytisus scoparius, the most abundant broom at Ellery Creek is French broom, Genista monspessulana; suggest you add it here. I will communicate with CNDDB. I have asked Len Lindstrand if he has observed Scotch broom in the Ellery Creek population. It's possible that both are there. Also, it would be more correct to say that Himalayan blackberry encroaches into many snow wreath populations, and that brooms (Scotch and French) are invasive in several populations.
16	5	The first three populations (actually more, I think seven) were found on limestone because that is where we looked. The Shasta-Trinity NF assembled a group of volunteers on May 1, 1993 (the year after publication), including authors Jim Shevock, who at that time was the USFS Regional Botanist for California, Dean Taylor, and Barbara Ertter. We assembled on the north shore of Shasta Lake. We distributed maps showing the distribution of limestone in the search area. Multiple parties set out by boat or vehicles to search the nearby limestone areas, and multiple new occurrences were found that day. You will note that Element Occurrrences 2-6 have a field form or other supporting material dated 1993-05-01. The fact that the first few populations were found on limestone is completely due to our bias in selecting search areas for the 1993 targeted group survey that were on mapped limestone. It was not until North State Resources began doing comprehensive field surveys for the Bureau of Reclamation Raise Shasta Dam project, that non-limestone occurrences started accumulating.
16	22	The area occupied by Shasta snow wreath is markedly more mild and mesic than any adjacent biomes (Klamath Mountains, southern Cascades, Central Valley) in terms of precipitation and temperature; this may explain why snow wreath became confined to this small geographic area over time.
20	11	add "inability to disperse rapidly because of failure to produce viable fruits with any dispersal mechanism"

page	line	comment
24	32	Waters Gulch trail was used as a fireline during a prescribed burn in the 1990s; the plants on either side of the trail were cut aboveground mechanically. They resprouted over the next few years.
26	30	Please add French broom to the list
32	19	Mitigation and recovery measures were developed by the Shasta-Trinity NF for the BOR Raise Shasta Dam project. These have not been implemented, because the BOR has not accepted the measures, and the Raise Shasta Dam project has not moved into the execution phase.
32	24	The Shasta-Trinity NF funded the monitoring, and when I got the manuscript for review, I was appalled to see that the HSU Foundation hires could not tell the difference between Abies concolor and Pseudotsuga menziesii. They recorded white fir as an associated species in most of the plots, when it does not co-occur with Shasta snow wreath AT ALL EVER. I wrote a pretty scathing review of the manuscript and they fixed the white fir-Doug-fir error, but I don't have much confidence in the results
34	1	also accidental herbicide application, as happened earlier on SPI
34	16	Add French broom (Genista monspessulana) to the list of invasive species. It is overwhelmingly present at Ellery Creek, though the CNDDB entry cites Scotch broom.

Peer Review Comments from Julie Kierstead on the Shasta Snow-wreath (*Neviusia cliftonii*) Status Review and California Department of Fish and Wildlife Responses

Page	Line	Reviewer Comment	Department Response
v	19	Add French broom (*Genista monspessulana*) to the list of invasive species. It is overwhelmingly present at Ellery Creek, though the CNDDB entry cites Scotch broom.	Text updated to add French broom.
12	5	Add "or both" to the end of the sentence; the two explanations for low allelic variation are not mutually exclusive, as both could be happening.	Text updated.
12	15	Neviusia growth form and shreddy bark are similar to oceanspray and ninebark, so unless flowers are present, it is easy to mistake the twigs and leaves of Neviusia for these other plants that grow in similar habitats and are present within the range of N. cliftonii. The flowering season for Neviusia cliftonii is short, so the period of time when mistaken ID is likely is long.	Text updated.
13		you may want to insert photos of the twigs and bark if you can find some	Comment noted. Suitable photos of the bark and twigs of all three species could not be found and were not added to the figure.
14	28	Although the CNDDB EO 3 (Ellery Creek) entry for threat comments identifies Rubus discolor/armeniacus and Cytisus scoparius, the most abundant broom at Ellery Creek is French broom, Genista monspessulana; suggest you add it here. I will communicate with CNDDB. I have asked Len Lindstrand if he has observed Scotch broom in the Ellery Creek population. It's possible that both are there. Also, it would be more correct to say that Himalayan blackberry encroaches into many snow wreath populations, and that brooms (Scotch and French) are invasive in several populations.	Text updated.

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16	22	The area occupied by Shasta snow wreath is markedly more mild and mesic than any adjacent biomes (Klamath Mountains, southern Cascades, Central Valley) in terms of precipitation and temperature; this may explain why snow wreath became confined to this small geographic area over time.	Comment noted. No response required.
20	11	add "inability to disperse rapidly because of failure to produce viable fruits with any dispersal mechanism"	Text updated to include information regarding lack of dispersal mechanism.
24	32	Waters Gulch trail was used as a fireline during a prescribed burn in the 1990s; the plants on either side of the trail were cut aboveground mechanically. They resprouted over the next few years.	Text updated to include this information.
26	30	Please add French broom to the list	Text updated to add French broom.

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34	1	also accidental herbicide application, as happened earlier on SPI	Text updated to add “accidental herbicide application.”
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GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

Date: 8/16/2021

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SUBJECT: STATUS REVIEW OF SHASTA SNOW-WREATH; CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW

Dear Len Lindstrand III:

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The peer review draft of the Department's Status Review forwarded to you today reflects the Department's effort to identify and analyze the best scientific information available regarding the status of Shasta snow-wreath in California. At this time, the

Department believes that the best available science indicates that listing the species as threatened under CESA is warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code. Our expected recommendation to the Commission at this point may change following peer review input.

We ask you to focus your peer review on the best scientific information available regarding the status of Shasta snow-wreath in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA are particularly important (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A)) (i.e., present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) as well as whether the information indicates, in your opinion, that Shasta snow-wreath, although not currently faced with extinction, is likely to become an endangered species in the foreseeable future in the absence of protection by CESA. Please note that the Department releases this Status Review to you solely as part of the peer review process, and it is not yet public.

A PDF version of the Status Review is included with this letter. For ease of review, and so we may respond to your comments individually, please submit your comments in list form by page and line number. Please submit your comments electronically to Cherilyn Burton, Senior Environmental Scientist (Specialist) at cherilyn.burton@wildlife.ca.gov. Cherilyn Burton may also be reached at (916) 206-0411. If there is anything the Department can do to facilitate your review, please let us know.

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Thank you again for your contribution to the Status Review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

DocuSigned by:
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September 10, 2021

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SUBJECT: Status Review of Shasta Snow-Wreath (*Neviusia cliftonii*), Peer Review Draft: August 16, 2021 - Lindstrand Scientific Peer Review Comments.

Dear Ms. Burton:

Enclosed please find scientific peer review comments to the subject document. These comments are intended to improve the analysis conducted for the Status Review and strengthen the resulting conclusions and whatever determination is ultimately made. Per the direction provided, my comments are provided below in list form by page and line number. Many of the comments also apply to the Executive Summary and Summary of Key Findings sections, but I did not repeat the comments in those sections for brevity.

Scientific Peer Review Comments

Page 6, line 33. The occurrence definition used by the CNDDB warrants additional discussion and perhaps revision in its use in this Status Review. The 0.25 mi. distance used by the CNDDB doesn't incorporate physical boundaries and often doesn't reflect the true number of distinct "occurrences" for a given taxa. For example, two proximate snow-wreath populations located at Ellery Creek (former EO#4) and south of Ellery Creek (EO#3) are considered one occurrence by the CNDDB (EO# 3); however, these populations occur in completely different stream drainages and are separated by a large ridgeline. The issue with the CNDDB occurrences is why the species locations used in Jules et al. (2017) describe 33 snow-wreath occurrences, as the information provided for that effort reflected geographic and biological occurrences and better represent distinct biological entities. This entire Status Review is based on 26 occurrences (redefined as populations) which is obviously different than 33. The information I previously provided CDFW upon their request for information summarizes 31 occurrences, which was refined from the aforementioned 33 upon additional site information. Regardless, impact analyses using numbers of occurrences or "populations" as a benchmark should properly disclose and analyze the locality information using what makes sense biologically, not by an arbitrary distance used in a resource agency database.

Further using Ellery Creek (former EO#4) and south of Ellery Creek (EO#3) as examples, and the proposed Shasta Dam enlargement described throughout this Status Review as a threat; the enlargement project would impact a small portion of the Ellery Creek occurrence and there would be no impact at the South of Ellery Creek occurrence, yet due to the arbitrary conflation, the "occurrence," which is actually two distinct locations, is identified as having an impact from

the proposed project since these are now considered one occurrence by the CNDDB (EO# 3). The potential impact, in terms of impacts to actual occurrences, is therefore overstated.

Page 8, line 22. General comment, I also have a few photos of some type of beetles (ID undetermined at this time) on an inflorescence at Ellery Creek from 2021.

Page 17, line 26. The discussion here is correct, but this overall doesn't fully describe the fire response. There was abundant vegetative response evident at the Ellery Creek population the first, second, and third season post-fire. Despite the lack of seedling response, the results from our study demonstrate the species responds well (vegetatively) to fire, as alluded to by Jules et al. (2017) and places the potential threat from fire to snow-wreath populations in context.

Page 17, line 27. See previous comment, these are completely separate populations; two populations were burned by the 2018 Hirz Fire.

Page 18, line 15. While little information may be available (formally) regarding population trends, having visited each known occurrence at least once, and most occurrences numerous times since their discovery; and conducting extensive field work in the areas around all these occurrences for years, I can offer that each occurrence has been stable and no reduction in the areal extent has occurred, and no new or impending threats have been observed. In fact, further refinement of previously identified potential threats has occurred and many of these occurrences "increased" compared to their original extent following additional survey time at the occurrence location(s) and vicinity. Numerous updated records have been submitted to the CNDDB which can be evaluated to generally provide population trends. Also, the summary I provided to CDFW upon their request for information, included in this Status Review in Appendix B, also shows current occurrence information and Element Rankings; note that 97% of the occurrences have updated rankings of Good or Excellent (assuming no Shasta Dam enlargement project) following the CNDDB ranking methods.

Page 19, line 35. The comment regarding bumblebees seems speculative and a bit of a reach in terms of the point being made here (snow-wreath not likely reproducing sexually).

Page 20, line 19. The concept discussed here seems conflated and perhaps confusing. The snow-wreath occurrences do exhibit low diversity within populations as shown in DeWoody et al. (2012); however, that doesn't detract from the fact that an occurrence consists of thousands of stems and is therefore "large" or conversely, a patch of a few stems being "small." Using another species as an example – are extensive quaking aspen stands considered "small" because they are related genetically? Also note in DeWoody et al. (2012) that two of the clusters shown in Fig. 2 include populations from multiple first order watersheds, so the low diversity at each population doesn't follow a geographic pattern. Another consideration of these occurrences characterized by low genetic diversity is that the genetic structure present is well suited for the particular location, otherwise they wouldn't exist there nor appear stable (per previous comment on page 18, line 15).

It is probably more prudent to describe these occurrences for what they are — very small to extensive populations characterized by low genetic diversity (presumably) due to predominately vegetative reproduction over time — rather than conflating population size and genetic diversity. Then perhaps integrating the concept of inherent risk to rare clonal species (e.g., Tepedino 2012) as another characteristic. The geographic range of this species has not experienced

glaciation or volcanism, which contributes to the narrow range. The closest relative is in the southeastern U.S., and relatives of the species once occurred in British Columbia. As relicts, the major climatic shifts, various glaciation cycles, and other catastrophic events over millions of years within the species range has influenced its current distribution but does not appear to compromise the ability to avoid species-level effects. Yes, they are isolated, and therefore susceptible to impacts, the question is, are there legitimate potential threats at these occurrences?

Page 20, line 22. This sentence seems overstated. The geology within the range of snow-wreath is not prone to instability. The listing petition includes this topic as a threat; however, no supporting analysis is provided. This Status Review also lacks supporting analysis. Is there any evidence of landslides at or even near a snow-wreath occurrence? I have been to each occurrence and never observed any slide features at the site(s) or vicinity. Even if there were a slide, unless significantly buried entirely, local impacts to a species such as snow-wreath with an extensive root system and sprouting capability could be minimal. Depending on the magnitude, such an event may even stimulate growth. I have observed this at a small scale at snow-wreath occurrences on old and recent roadcut surfaces, and areas where large conifers fell on steep slopes, creating a "slide" that was colonized by snow-wreath from adjacent stems.

Regarding drought as stated here, given how long this species has been around and how much climate variability that has occurred during that time, I find It difficult to suggest drought could result in the loss of a population. I believe any potential impacts from stochastic events would be from something human-caused.

Page 21, line 16. The Status Review states this proposed Shasta Dam enlargement project as a potential threat as fact and doesn't describe the current status that the proposed project is currently not moving forward. Besides several politicians, most in the industry consider the project dead or otherwise "not happening." Among other issues, there is no state or private funding partner, required by law as the Federal government can only fund 50% of the cost, and no state agency can legally become the CEQA Lead Agency and provide CEQA approval. How would the analysis for this Status Review be affected by excluding this proposed project? It seems prudent to include a scenario in the Status Review without the proposed project and the associated potential threats. Also, if the proposed dam project is identified a as threat to the species and treated as a "real project" then the Status Review makes no mention of the numerous minimization and mitigation measures for snow-wreath proposed by the project if it were to move forward and (presumably) did not include those in the analysis. These measures are all described and included in the project NEPA and supporting documents. Interestingly, several of the items described in the Management Recommendations and Recovery Measures section of this Status Review are included in the mitigations for the proposed project.

Page 21, line 28. See previous comment regarding occurrences. This is one example how impact analyses and conclusions are influenced by the definition of a "population."

Page 22, line 6. Shortly following their discovery I fully documented these populations in the field, including collecting herbarium specimens and flagging the population boundaries for subsequent total station survey. The CNDDB EO#24 is very small (20-30 plants) and would be entirely inundated; however, biologically this population is part of the much larger Stein Creek occurrence and that is how I considered the impact at the time. The extent of EO#25 is shown here in the Status Review, I estimated the inundation area as approximately 0.10 acre. EO#'s

27 (Bear Canyon) and 28 (Roberts Canyon) are approximately 1.0 and 0.75 acres in size, respectively; approximately 0.10 and 0.20 acres of which would be inundated, respectively. Total station survey data collected by Westlands Water District would refine these numbers, but I believe they are fairly accurate, certainly for the scale of this level of analysis.

Page 23, line 4. This is incorrect, the proportional impact would be slightly less than currently described. The area of these populations is greater above the inundation line than below, which would increase the overall population size and proportionately reduce the amount impacted by flooding.

Page 23, line 13. This paragraph seems a bit overstated and is somewhat speculative. The USFS recreation specialists can expand on the use patterns, but I can say, besides Waters Gulch of course because of the hiking trail, there is no evidence of human disturbances at the snow-wreath populations near the lake. Despite the proximity to the lake, these areas aren't subject to any regular human visitation. The recreation at Shasta Lake is focused on the lake itself and the shoreline when exposed. The uplands are steep, brushy, full of poison oak, and very hot (particularly during the recreation season). Unless there is a flat location (uncommon), there isn't much disturbance to the uplands adjacent to the lake.

Page 23, line 19. Correct, CALFIRE is the lead agency for the California Forest Practice Rules (CFPRs). Also, worth mentioning for complete understanding is that the CFPRs consist of a multi-agency process and includes The California Department of Fish and Wildlife, California Regional Water Quality Control Board, and California Geological Survey.

Page 23, line 23. The Forest Practice Act and accompanying CFPRs are the functional equivalent of CEQA. Is the Status Review saying special-status plants, particularly those not federally or state listed, are given less consideration under CEQA? This sentence suggests the Forest Practice Act is some type of process outside of CEQA and somehow legislated differently. Yes, listed species are given greater consideration during state and federal planning processes, as they are protected under CESA and FESA which have additional mandates, but please explain how (other) special-status plants are given less consideration under CEQA and the Forest Practice Act and how this relates to the Status Review. Following the seven initial occurrences found during the species discovery and shortly thereafter, all of the information we have regarding snow-wreath is due to the existing regulatory framework, including CEQA, NEPA, and USFS planning documents. This suggests the existing regulatory framework is working, certainly to some extent, and should be properly disclosed.

Page 23, line 30. The Stein Creek occurrence (EO#12) is large and extensive. Following significant planning to revise road layout and minimize impacts to snow-wreath, the approved THP impacted several snow-wreath shrubs/patches at two road crossings located across stream drainages. These impacts represented a very small proportion of the overall occurrence. Nearly all of the Stein Creek snow-wreath shrubs occur along drainages and subsequently are protected within Watercourse and Lake Protections Zones (WLPZ) required by the CFPRs. In one instance where snow-wreath extended upslope beyond the WLPZ that was adjacent to a proposed harvest area, SPI established a Habitat Retention Area (HRA) to protect the snow-wreath. Visits to these sites during the past two years show the snow-wreath is extant and in excellent condition immediately adjacent (and the extent beyond) to these road crossings, in the HRA, and areas outside the timberland management activities. This updated

information was provided to the CNDDB, and to CDFW per their information request for this Status Review.

Page 23, line 38. SPI also completed transect monitoring during 2015, 2017, and 2019.

Page 24, line 3. The herbicide did kill some snow-wreath. Since the application, snow-wreath has begun to spread into this area from adjacent shrubs. Careful treatment further targeting Himalayan blackberry would enhance this population. Also, since this incident, subsequent herbicide treatment in the area was preceded by clearly establishing updated no-treatment areas, and crew supervision was improved during a follow-up application.

Page 24, line 6. The harvest activities planned for the snow-wreath occurrence (proper) did not occur. Several trees were harvested along the edge of the occurrence and a skid trail was created, but the "before and after" monitoring as planned is not currently active. SPI has four years of transect data for future activities in this area or for use in other applications. Anecdotal monitoring occurs at the location where several trees were harvested and skid trail occurred, and at the previously described "herbicide area."

Page 24, line 14. Most of this occurrence is not on SPI property. Updated information was provided to the CNDDB.

Page 24, line 16. Technically anything "could" happen. However, the Status Review described above three examples of snow-wreath and the CFPR process which resulted in no substantial reduction to snow-wreath during two THP efforts and no impact at a third. This suggests that the CFPR regulatory process (i.e., CEQA) is working to protect snow-wreath when the species has been found during THP planning efforts.

Page 24, line 20. I suggest providing additional explanation here. While not formally protected per se, any (legal) activities proposed by a landowner at that site would be subject to county permitting at a minimum, likely triggering CEQA; SMARA if they were mining related, the CFPRs if timber harvest related; and would require CDFW 1600 Agreements if involving the nearby stream.

Page 24, line 23. This is called the Fawndale Quarry (Mountain Gate is the location), operated by J.F. Shea, not Stimple-Wiebehaus.

Page 24, line 27. It is worth noting that this parcel is an inholding in the Shasta-Trinity National Forest and also adjacent to a portion of the USFS Hosselkuss Research Natural Area. The portion of the parcel in which the snow-wreath occurs is a steep slope at the base of an even steeper limestone cliff formation, all of which is located upslope of a USFS road. No development could occur here, as has occurred in similar inholdings in the vicinity where cabins are located.

Page 26, line 30. Also, French broom (*Genista monspessulana*).

Page 28, line 9. The listing petition includes this topic as a threat; however, no supporting analysis is provided. This Status Review provides some supporting analysis, but none or speculative evidence of impacts to this species. I suggest the Status Review include a discussion of any evidence that climate change is affecting a snow-wreath occurrence or its

habitat. Additionally, if using increased fire as evidence of climate change, I suggest that analysis include discussion of the proportion of the fire issues that are related to climate change vs. how historic and recent management of the forest habitats in the species range has influenced current fire conditions and forest health (i.e., absent climate change). Perhaps integrating some of the information provided in the Altered Fire Regimes section below.

Page 28, line 22. This citation is not included in the References section.

Page 29, line 28. Not part of this review, but it would be interesting to see how the USFS can demonstrate these criteria are met; notwithstanding the unknown regarding what was likely impacted by creation of Shasta Lake, I don't see a downward population trend, if anything an upward trend has occurred as more populations have been located since the species was discovered, and the occurrences and habitat have been stable overall. If the USFS has some documentation, perhaps that may be useful. This species is also considered Sensitive by the California BLM, I am unsure of the details regarding the criteria for such a designation. The generic information provided doesn't seem to match the snow-wreath habitat or species ecology (see comment on page 35, line 11 below).

Page 32, line 33. While not formal monitoring, many of these occurrences have been subject to regular updates which have been submitted to the CNDDB. These updates include habitat condition, population size, numbers, etc., and observed threats if applicable. Review of these updates can certainly show trends and would show many of the occurrences as stable overall and in many instances the occurrence boundaries have been updated (increased) due to additional time spent and detailed work at these locations.

Page 34, line 5. Per the previous comment on page 21, given the proposed Shasta Dam project is inactive, is it prudent to provide analysis as if the project were proceeding? If this project isn't proceeding in the foreseeable future should the analysis include an alternative where there is no proposed enlargement and associated threats? Given this proposed project is included in the Status Review, did the analysis consider the numerous minimization and mitigation measures for snow-wreath proposed by the project if it were to move forward?

Page 35, line 11. More explanation is needed here. How does the climate change model used in this analysis show snow-wreath habitat shifting upwards in elevation? The species distribution excludes higher elevation areas within its range currently, so why would it shift to higher areas? This sounds more like a climate change scenario for a species more closely linked to snowpack. The existing snow-wreath occurrences are characterized as low elevation sites in canyons along streams and other cooler-aspect slopes; all of which are within an area subject to high annual precipitation. The species does not occur in higher elevation areas within its range due to those areas having cooler average temperatures and increased instances of persistent snow. Other southeastern Klamath Ranges endemics show a similar pattern. Climate models showing warmer and wetter trends suggest the existing habitat would persist and perhaps additional areas within the species range may become suitable.

Page 35, line 14. This may work both ways, as these topographical characteristics are also providing the very refugia the species uses and considerably influences its distribution.

Page 35, line 18. I understand this is a possible threat, as it has happened once before. That said, this is a very minimal threat because the likelihood of this happening again is very low.

Besides the USFS project at Waters Gulch that may be using herbicide for weed control, there are no snow-wreath occurrences in areas subject to herbicide use. Herbicide application at the McCandless Gulch occurrence (where herbicide killed snow-wreath) is completed and the other occurrences on SPI lands are outside of areas where herbicide treatment would occur. As described, this paragraph is vague and somewhat speculative, particularly in the context of the number of occurrences where herbicide could be used. Please provide more information where this threat could actually occur.

Page 37, line 25. I suggest an expanded discussion, how will "management actions required by CESA" provide special protection to the species? Per this Status Review, the USFS owns 67 percent of the snow-wreath habitat. The USFS planning process, NEPA, and ESA do not recognize CESA-listed species on federal lands. However, snow-wreath is considered a Sensitive species by the USFS and is therefore integrated into forest planning and NEPA analyses. The greatest species threat identified in the Status Review, in terms of habitat loss, is a federal project on federal lands. Did the analysis for the Species Review consider what, if any benefit a state-listing would provide to the species considering such a listing would make no difference to the existing regulatory framework for federal agencies on federal lands?

Page 38, line 4. Is the Status Review suggesting the existing CEQA and NEPA framework isn't working? Existing information suggests it is. Again, all we know about the species aside from seven populations found during the initial discovery and subsequent efforts is due to existing regulatory requirements. In addition to planning level information, these requirements have also resulted in on-the-ground minimization and protection measures for the species.

Page 38, line 11. There is no guarantee of additional funding by any means, per the following sentence. What can be said more definitively is that any activities around listed species occurrences become increasingly challenging and difficult, often resulting in nothing being done simply because management agencies, project proponents, or regulatory agencies are unable or unwilling to navigate the consultation process. This includes circumstances that could provide conservation benefit.

A relevant example of this for snow-wreath are the administrative and legal challenges the USFS faced when proposing invasive species control and fuels reduction at the Waters Gulch snow-wreath occurrence, portions of which are being impacted by an invasive broom population. After a lengthy process to complete their NEPA documents, the proposed project was challenged due to proposed herbicide use (shown in the NEPA document to be very low risk of detrimental effects) and the project stalled as the USFS was unable to readily complete updated project planning and revised NEPA documents. A local consultancy, on behalf of the Bureau of Reclamation (BOR) who was interested in potential snow-wreath mitigation measures at the time due to the proposed Shasta Dam enlargement, worked with the USFS to revise the project and complete the NEPA documents. Sadly, the original proposed project was reduced and made less effective relative to the need for invasive species control for snow-wreath and fuels reduction due to concerns related to the initial legal challenge. Nonetheless, the project finally made it through the NEPA process and some initial on-the-ground work has been completed.

The three main points here are (1) the USFS itself struggled to complete the NEPA process, (2) the project stalled upon legal challenge and created additional delays, (3) an outside interest had to be the lead, provide funding, and bring the project to completion, otherwise the project

would unlikely have been approved, or it would certainly have taken much longer. All of this happened for a non-listed species in a situation where the threat from invasive species is painfully obvious even to an untrained observer – while the USFS wouldn't recognize a state listing anyway, how would this possibly have been made easier if the species were state-listed? This was the single time the USFS directly dealt with this species on a project (besides trail maintenance at Waters Gulch and a small prescribed fire at Jones Valley). I can't see how a state listing would make the USFS, who owns 67% of the occupied snow-wreath habitat per this Status Review, more prone to attempt management activities.

Page 38, line 28. I understand these are CDFW recommendations, but inevitably they provide groundwork for recovery actions. Please explain why these measures cannot be accomplished currently or if that has even been discussed. Does the listing petition describe whether attempts have been made to discuss or implement such measures and failure to do so has created an impediment to proposed conservation measures? Also, please explain why it's implied a species must be listed in order for these actions to occur, and how this affected the analysis for the Status Review. Did the Status Review consider if these actions were enacted whether the recommendation to list as threatened would still apply? How would these actions be enacted if the agency that owns 67% of the snow-wreath habitat, yet doesn't recognize a state-listed species, is not engaged in these processes? Will the USFS commit to these measures?

While conducting work for the proposed Shasta Dam enlargement project a technical group was formed to initiate many of the items listed below with the goal of creating a snow-wreath management plan. The group initially included the CDFW, USFS, USFWS, and the BOR (via their representative). Other stakeholders would have also been invited if the proposed project had continued. The primary nexus was a management plan completed in the late-2000s by the NPS, USFWS, Caltrans, and CDFW for *Puccinellia howellii*, which is known from a single location located along Clear Creek and Highway 299W, near Whiskeytown Lake, several miles southwest of the snow-wreath range. This plan and accompanying implementation measures prevented the species from becoming listed. That plan served as a model for the snow-wreath group and was considered a way to bring all interested parties together and perform effective management without the complications of trying to do so for a listed species. If a plan can be implemented for a species with a single occurrence adjacent to a state highway, why can't one be completed for a species with numerous occurrences spread over a relatively large area? A similar plan could be developed by the USFS focusing on federal lands to address the federal petition to list snow-wreath under the ESA, such as the plan developed by the Klamath National Forest for *Calochortus persistens*, which was completed to avoid federal listing of this state-listed plant.

It seems that any answers regarding conservation issues for this species must include the USFS and they must play an engaged, active role. The listing petition fails to describe whether the USFS is unable to do so, and if discussions regarding the matter have even occurred. The Status Review lacks details describing how a state listing changes any of those issues and what conservation or regulatory benefit would occur, that is not already occurring, on the non-federal snow-wreath issue areas.

Appendix A, row for CNDDB Occurrence #3. Small detail, but this is actually French broom, a correction has been submitted to the CNDDB.

Appendix A, row for CNDDB Occurrence #12. Why the description here of the nuances behind the mapping? Each occurrence has nuances behind the mapped boundaries, accuracy, the "CNDDB buffer issue," and even completeness (e.g., the Curl Creek occurrence is not fully mapped). This isn't explained nor applied in the Status Review, yet appears here to suggest the occurrence may be smaller. Regarding ramet population size; there has never been a complete population estimate of this occurrence conducted at the same time, rather the estimates provided represent only the portions of the occurrence recorded for the particular data collecting event at that time for which the data was provided to the CNDDB. Also note the plant material collected for the DeWoody et al. (2012) study was from the lower portion of the occurrence near the Stein Creek/Shasta Lake confluence, as that was all known at the time regarding the extent of the occurrence, and did not include the portions of the occurrence in the upper watershed.

Appendix A, row for CNDDB Occurrence #22. This reads as past tense given the timing of the original record submittal. The timber harvest and subsequent reforestation efforts here are completed at this location. The plants were protected in a WLPZ and HRA. Updated records have been submitted to the CNDDB, herbarium specimens have been collected, and the site was included among several shown to CDFW during April 2021.

Appendix A, row for CNDDB Occurrence #23. See previous comments and supplemental information provided to CDFW regarding this occurrence. The timber harvest did not occur as planned and only a small portion was subject to selected tree removal.

Overall comments. This Status Review does a good job describing the species discovery, biology, and general distribution. The Review also provides context for the primary ecological characteristics of the species; a relict taxon consisting of relatively few populations, low genetic diversity within populations, high differentiation between populations, and limited dispersal capability. However, the Status Review also has shortcomings that I believe start with the listing petition. The petition presents numerous potential threats to the species, but besides the Shasta Dam project, lacks substantial evidence that these threats previously, currently, or in the foreseeable future (i.e., degree and immediacy) result in species impacts warranting listing. The Status Review includes similar speculative information regarding these potential threats and lacks detailed description of how the existing regulatory framework is not providing adequate species protection when evidence suggests otherwise. These issues in turn do not provide the clarity and foundation I believe necessary to support a comprehensive evaluation and Status Review.

There seems to be a disconnect in the listing petition and this Status Review between a potential threat and the likelihood of that threat actually happening. Several of the topics presented as threats are generalized and lack evidence that they are occurring or will occur in the foreseeable future. With that as context, when I look at each snow-wreath occurrence and potential threats – what is currently or in the future going to become an issue at that location? Then when I read the Scientific Determinations in the Status Review, aside from the dam enlargement project, we are left evaluating very minor impacts from THPs, and no overexploitation, predation, competition, or disease. Then in the Other Natural Occurrences or Human-related Activities section we are left evaluating climate change or other disturbances (with no mention of what "other disturbances" are…), and a very unlikely threat from herbicides. While snow-wreath is a relict with relatively few populations, low genetic diversity and high differentiation, and limited dispersal capability, the conclusions presented lack compelling evidence that there are actually on-going threats or threats that will occur in the foreseeable

future that would be changed by a state listing. I would like to see why potential threats to the species (supposedly) can't be addressed by conservation measures afforded under the existing regulatory framework and how a state listing would change any of those circumstances for the benefit of the species.

Finally, per previous comments, the issue of the Shasta Dam project and how the project factors into this analysis needs further refinement. If the project isn't moving forward, why does this Status Review assume otherwise? If it is not moving forward but also not conclusively dead, how does the Status Review and potential CESA listing deal with a "looming" potential threat that may never occur?

Thank you for the hard work put into this effort and the opportunity to provide input during your Status Review. I hope these comments help provide additional detail to strengthen the analysis and better support the Status Review. Please feel free to contact me with any questions or comments.

Sincerely,

/s/ Len Lindstrand III

Len Lindstrand III, CWB®
Terrestrial and Aquatic Biologist
Botany Program Manager

Peer Review Comments from Len Lindstrand III on Shasta Snow-wreath (*Neviusia cliftonii*) Status Review and California Department of Fish and Wildlife Responses

Page	Line	Reviewer Comment	Department Response
6	33	The occurrence definition used by the CNDDB warrants additional discussion and perhaps revision in its use in this Status Review. The 0.25 mi. distance used by the CNDDB doesn't incorporate physical boundaries and often doesn't reflect the true number of distinct "occurrences" for a given taxa. For example, two proximate snow-wreath populations located at Ellery Creek (former EO#4) and south of Ellery Creek (EO#3) are considered one occurrence by the CNDDB (EO# 3); however, these populations occur in completely different stream drainages and are separated by a large ridgeline. The issue with the CNDDB occurrences is why the species locations used in Jules et al. (2017) describe 33 snow-wreath occurrences, as the information provided for that effort reflected geographic and biological occurrences and better represent distinct biological entities. This entire Status Review is based on 26 occurrences (redefined as populations) which is obviously different than 33. The information I previously provided CDFW upon their request for information summarizes 31 occurrences, which was refined from the aforementioned 33 upon additional site information. Regardless, impact analyses using numbers of occurrences or "populations" as a benchmark should properly disclose and analyze the locality information using what makes sense biologically, not by an arbitrary distance used in a resource agency database. Further using Ellery Creek (former EO#4) and south of Ellery Creek (EO#3) as examples, and the proposed Shasta Dam enlargement described throughout this Status Review as a threat; the enlargement project would impact a small portion of the Ellery Creek occurrence and there would be no impact at the South of Ellery Creek occurrence, yet due to the arbitrary conflation, the "occurrence," which is actually two distinct locations, is identified as having an impact from the proposed project since these are now considered one occurrence by the CNDDB (EO# 3). The potential impact, in terms of impacts to actual occurrences, is therefore overstated.	Text updated to describe the distinction between a "population" and CNDDB element occurrence. Text updated throughout to clarify between the two terms as necessary.
8	22	General comment, I also have a few photos of some type of beetles (ID undetermined at this time) on an inflorescence at Ellery Creek from 2021.	Text updated to include this observation.

Page	Line	Reviewer Comment	Department Response
17	26	The discussion here is correct, but this overall doesn't fully describe the fire response. There was abundant vegetative response evident at the Ellery Creek population the first, second, and third season post-fire. Despite the lack of seedling response, the results from our study demonstrate the species responds well (vegetatively) to fire, as alluded to by Jules et al. (2017) and places the potential threat from fire to snow-wreath populations in context.	Text updated to indicate that the two Shasta snow-wreath populations were able to recover from a single fire event.
17	27	See previous comment, these are completely separate populations; two populations were burned by the 2018 Hirz Fire.	Text updated to describe these as two populations.
18	15	While little information may be available (formally) regarding population trends, having visited each known occurrence at least once, and most occurrences numerous times since their discovery; and conducting extensive field work in the areas around all these occurrences for years, I can offer that each occurrence has been stable and no reduction in the areal extent has occurred, and no new or impending threats have been observed. In fact, further refinement of previously identified potential threats has occurred and many of these occurrences "increased" compared to their original extent following additional survey time at the occurrence location(s) and vicinity. Numerous updated records have been submitted to the CNDDB which can be evaluated to generally provide population trends. Also, the summary I provided to CDFW upon their request for information, included in this Status Review in Appendix B, also shows current occurrence information and Element Rankings; note that 97% of the occurrences have updated rankings of Good or Excellent (assuming no Shasta Dam enlargement project) following the CNDDB ranking methods.	Text updated to indicate populations appear relatively stable.
19	35	The comment regarding bumblebees seems speculative and a bit of a reach in terms of the point being made here (snow-wreath not likely reproducing sexually).	Text updated to remove this sentence.

Page	Line	Reviewer Comment	Department Response
20	19	The concept discussed here seems conflated and perhaps confusing. The snow-wreath occurrences do exhibit low diversity within populations as shown in DeWoody et al. (2012); however, that doesn't detract from the fact that an occurrence consists of thousands of stems and is therefore "large" or conversely, a patch of a few stems being "small." Using another species as an example – are extensive quaking aspen stands considered "small" because they are related genetically? Also note in DeWoody et al. (2012) that two of the clusters shown in Fig. 2 include populations from multiple first order watersheds, so the low diversity at each population doesn't follow a geographic pattern. Another consideration of these occurrences characterized by low genetic diversity is that the genetic structure present is well suited for the particular location, otherwise they wouldn't exist there nor appear stable (per previous comment on page 18, line 15). It is probably more prudent to describe these occurrences for what they are — very small to extensive populations characterized by low genetic diversity (presumably) due to predominately vegetative reproduction over time — rather than conflating population size and genetic diversity. Then perhaps integrating the concept of inherent risk to rare clonal species (e.g., Tepedino 2012) as another characteristic. The geographic range of this species has not experienced glaciation or volcanism, which contributes to the narrow range. The closest relative is in the southeastern U.S., and relatives of the species once occurred in British Columbia. As relicts, the major climatic shifts, various glaciation cycles, and other catastrophic events over millions of years within the species range has influenced its current distribution but does not appear to compromise the ability to avoid species-level effects. Yes, they are isolated, and therefore susceptible to impacts, the question is, are there legitimate potential threats at these occurrences?	Text modified to clarify that populations are small to extensive in terms of ramets or above ground stems, but they exhibit low genetic diversity. Further modified text to describe risks due to low genetic diversity and due to restricted range of the species, and to clarify the potential threats to these isolated populations.

Page	Line	Reviewer Comment	Department Response
20	22	This sentence seems overstated. The geology within the range of snow-wreath is not prone to instability. The listing petition includes this topic as a threat; however, no supporting analysis is provided. This Status Review also lacks supporting analysis. Is there any evidence of landslides at or even near a snow-wreath occurrence? I have been to each occurrence and never observed any slide features at the site(s) or vicinity. Even if there were a slide, unless significantly buried entirely, local impacts to a species such as snow-wreath with an extensive root system and sprouting capability could be minimal. Depending on the magnitude, such an event may even stimulate growth. I have observed this at a small scale at snow-wreath occurrences on old and recent roadcut surfaces, and areas where large conifers fell on steep slopes, creating a "slide" that was colonized by snow-wreath from adjacent stems. Regarding drought as stated here, given how long this species has been around and how much climate variability that has occurred during that time, I find It difficult to suggest drought could result in the loss of a population. I believe any potential impacts from stochastic events would be from something human-caused.	Text updated to remove specific references to landslides and drought, and more generally described these risks as "environmental changes."

Page	Line	Reviewer Comment	Department Response
21	16	The Status Review states this proposed Shasta Dam enlargement project as a potential threat as fact and doesn't describe the current status that the proposed project is currently not moving forward. Besides several politicians, most in the industry consider the project dead or otherwise "not happening." Among other issues, there is no state or private funding partner, required by law as the Federal government can only fund 50% of the cost, and no state agency can legally become the CEQA Lead Agency and provide CEQA approval. How would the analysis for this Status Review be affected by excluding this proposed project? It seems prudent to include a scenario in the Status Review without the proposed project and the associated potential threats. Also, if the proposed dam project is identified a as threat to the species and treated as a "real project" then the Status Review makes no mention of the numerous minimization and mitigation measures for snow-wreath proposed by the project if it were to move forward and (presumably) did not include those in the analysis. These measures are all described and included in the project NEPA and supporting documents. Interestingly, several of the items described in the Management Recommendations and Recovery Measures section of this Status Review are included in the mitigations for the proposed project.	Text modified to include challenges to the project moving forward. However, the Department must consider the project as active since there is nothing to indicate that efforts to move the project forward have stopped. The Final Supplemental Environmental Impact Study (EIS) was completed in November 2020. It would not be appropriate to exclude the project from the analysis because there is still a likelihood of it moving forward and being implemented in the foreseeable future. New legislation could be passed or exceptions made that would allow the project to move forward. Therefore, the Department considers the project to raise the height of Shasta Dam as having the potential to occur in the foreseeable future (i.e., by the end of the century), and must consider potential impacts from this project on Shasta snow-wreath as part of this Status Review. The Department acknowledges there are numerous minimization and mitigation measures described in the Final EIS. The Final EIS indicates that impacts to Shasta snow-wreath would be significant and unavoidable, even with the implementation of the mitigation measures.

Page	Line	Reviewer Comment	Department Response
21	28	See previous comment regarding occurrences. This is one example how impact analyses and conclusions are influenced by the definition of a "population."	Text updated to reflect impacts to populations and element occurrences.
22	6	Shortly following their discovery I fully documented these populations in the field, including collecting herbarium specimens and flagging the population boundaries for subsequent total station survey. The CNDDB EO#24 is very small (20-30 plants) and would be entirely inundated; however, biologically this population is part of the much larger Stein Creek occurrence and that is how I considered the impact at the time. The extent of EO#25 is shown here in the Status Review, I estimated the inundation area as approximately 0.10 acre. EO#'s 27 (Bear Canyon) and 28 (Roberts Canyon) are approximately 1.0 and 0.75 acres in size, respectively; approximately 0.10 and 0.20 acres of which would be inundated, respectively. Total station survey data collected by Westlands Water District would refine these numbers, but I believe they are fairly accurate, certainly for the scale of this level of analysis.	Text updated to include the additional information regarding population size and impact area.
23	4	This is incorrect, the proportional impact would be slightly less than currently described. The area of these populations is greater above the inundation line than below, which would increase the overall population size and proportionately reduce the amount impacted by flooding.	Text updated to remove this statement.
23	13	This paragraph seems a bit overstated and is somewhat speculative. The USFS recreation specialists can expand on the use patterns, but I can say, besides Waters Gulch of course because of the hiking trail, there is no evidence of human disturbances at the snow-wreath populations near the lake. Despite the proximity to the lake, these areas aren't subject to any regular human visitation. The recreation at Shasta Lake is focused on the lake itself and the shoreline when exposed. The uplands are steep, brushy, full of poison oak, and very hot (particularly during the recreation season). Unless there is a flat location (uncommon), there isn't much disturbance to the uplands adjacent to the lake.	Text updated to indicate that current human disturbance at the Shasta snow-wreath populations along the shoreline is currently low.

Page	Line	Reviewer Comment	Department Response
23	19	Correct, CALFIRE is the lead agency for the California Forest Practice Rules (CFPRs). Also, worth mentioning for complete understanding is that the CFPRs consist of a multi-agency process and includes The California Department of Fish and Wildlife, California Regional Water Quality Control Board, and California Geological Survey.	Text updated to reflect that the California Department of Fish and Wildlife, California Regional Water Quality Control Board, and California Geological Survey are given the opportunity to review and comment on Timber Harvesting Plans.
23	23	The Forest Practice Act and accompanying CFPRs are the functional equivalent of CEQA. Is the Status Review saying special-status plants, particularly those not federally or state listed, are given less consideration under CEQA? This sentence suggests the Forest Practice Act is some type of process outside of CEQA and somehow legislated differently. Yes, listed species are given greater consideration during state and federal planning processes, as they are protected under CESA and FESA which have additional mandates, but please explain how (other) special-status plants are given less consideration under CEQA and the Forest Practice Act and how this relates to the Status Review. Following the seven initial occurrences found during the species discovery and shortly thereafter, all of the information we have regarding snow-wreath is due to the existing regulatory framework, including CEQA, NEPA, and USFS planning documents. This suggests the existing regulatory framework is working, certainly to some extent, and should be properly disclosed.	Text updated to indicate that CESA listed species are afforded additional protections through the Incidental Take Permitting process. While CEQA and the CFPRs require disclosure of impacts and protection of endangered, rare, threatened species, mitigation requirements are to less-than-significant levels. Impacts to CESA-listed species must be fully mitigated. Thus, CESA-listed species are afforded stronger protections than unlisted species.

Page	Line	Reviewer Comment	Department Response
23	30	The Stein Creek occurrence (EO#12) is large and extensive. Following significant planning to revise road layout and minimize impacts to snow-wreath, the approved THP impacted several snow-wreath shrubs/patches at two road crossings located across stream drainages. These impacts represented a very small proportion of the overall occurrence. Nearly all of the Stein Creek snow-wreath shrubs occur along drainages and subsequently are protected within Watercourse and Lake Protections Zones (WLPZ) required by the CFPRs. In one instance where snow-wreath extended upslope beyond the WLPZ that was adjacent to a proposed harvest area, SPI established a Habitat Retention Area (HRA) to protect the snow-wreath. Visits to these sites during the past two years show the snow-wreath is extant and in excellent condition immediately adjacent (and the extent beyond) to these road crossings, in the HRA, and areas outside the timberland management activities. This updated information was provided to the CNDDB, and to CDFW per their information request for this Status Review.	Text updated to include general information about these activities and protection measures. Specific information defining WLPZ and HRA designations was not included as that is considered outside of the scope of this analysis.
23	38	SPI also completed transect monitoring during 2015, 2017, and 2019.	Text updated to include this information.
24	3	The herbicide did kill some snow-wreath. Since the application, snow-wreath has begun to spread into this area from adjacent shrubs. Careful treatment further targeting Himalayan blackberry would enhance this population. Also, since this incident, subsequent herbicide treatment in the area was preceded by clearly establishing updated no-treatment areas, and crew supervision was improved during a follow-up application.	Comment noted. The Status Review provides information on impacts that have occurred. The Department acknowledges that Shasta snow-wreath may recover from herbicide treatment, but still considers inadvertent herbicide as a risk in the future.
24	6	The harvest activities planned for the snow-wreath occurrence (proper) did not occur. Several trees were harvested along the edge of the occurrence and a skid trail was created, but the “before and after” monitoring as planned is not currently active. SPI has four years of transect data for future activities in this area or for use in other applications. Anecdotal monitoring occurs at the location where several trees were harvested and skid trail occurred, and at the previously described “herbicide area.”	Text updated to indicate the timber harvest activities occurred along the edge of the population.
24	14	Most of this occurrence is not on SPI property. Updated information was provided to the CNDDB.	Text updated to clarify this occurrence is partially located on SPI property.

Page	Line	Reviewer Comment	Department Response
24	16	Technically anything "could" happen. However, the Status Review described above three examples of snow-wreath and the CFPR process which resulted in no substantial reduction to snow-wreath during two THP efforts and no impact at a third. This suggests that the CFPR regulatory process (i.e., CEQA) is working to protect snow-wreath when the species has been found during THP planning efforts.	Text updated to reflect recent timber harvest practices have implemented measures to minimize impacts to Shasta snow-wreath, and that future timber harvest could affect this species without avoidance.
24	20	I suggest providing additional explanation here. While not formally protected per se, any (legal) activities proposed by a landowner at that site would be subject to county permitting at a minimum, likely triggering CEQA; SMARA if they were mining related, the CFPRs if timber harvest related; and would require CDFW 1600 Agreements if involving the nearby stream.	Comment noted. Although existing regulations and laws could benefit Shasta snow-wreath in some situations, there is nothing specifically protecting Shasta snow-wreath at this population.
24	23	This is called the Fawndale Quarry (Mountain Gate is the location), operated by J.F. Shea, not Stimple-Wiebehaus.	Text updated.
24	27	It is worth noting that this parcel is an inholding in the Shasta-Trinity National Forest and also adjacent to a portion of the USFS Hosselkuss Research Natural Area. The portion of the parcel in which the snow-wreath occurs is a steep slope at the base of an even steeper limestone cliff formation, all of which is located upslope of a USFS road. No development could occur here, as has occurred in similar inholdings in the vicinity where cabins are located.	Comment noted. Text updated to include that Shasta snow-wreath occurs at the base of a limestone cliff and development is unlikely here. Information regarding the location of the parcel in an inholding and adjacent to the USFS Hosselkuss Research Natural Area not added as it does not seem relevant here.
26	30	Also, French broom (*Genista monspessulana*).	Text updated to include French broom.

Page	Line	Reviewer Comment	Department Response
28	9	The listing petition includes this topic as a threat; however, no supporting analysis is provided. This Status Review provides some supporting analysis, but none or speculative evidence of impacts to this species. I suggest the Status Review include a discussion of any evidence that climate change is affecting a snow-wreath occurrence or its habitat. Additionally, if using increased fire as evidence of climate change, I suggest that analysis include discussion of the proportion of the fire issues that are related to climate change vs. how historic and recent management of the forest habitats in the species range has influenced current fire conditions and forest health (i.e., absent climate change). Perhaps integrating some of the information provided in the Altered Fire Regimes section below.	Text updated to add information about climate change trends in California and in the region where Shasta snow-wreath occurs. No information specific to climate change effects on Shasta snow-wreath or its habitat is available. General information on regional climate change trends and effects was consulted and summarized in this section. Information on fire effects due to climate change was added to the Altered Fire Regimes section.
28	22	This citation is not included in the References section.	Citation added to literature cited section.
29	28	Not part of this review, but it would be interesting to see how the USFS can demonstrate these criteria are met; notwithstanding the unknown regarding what was likely impacted by creation of Shasta Lake, I don't see a downward population trend, if anything an upward trend has occurred as more populations have been located since the species was discovered, and the occurrences and habitat have been stable overall. If the USFS has some documentation, perhaps that may be useful. This species is also considered Sensitive by the California BLM, I am unsure of the details regarding the criteria for such a designation. The generic information provided doesn't seem to match the snow-wreath habitat or species ecology (see comment on page 35, line 11 below).	Comment noted. The Department could not find information indicating this species is currently listed as a BLM sensitive species. The list of BLM sensitive plant species in California from 2015 lists Shasta snow-wreath as a BLM sensitive species. A more recent list from January 17, 2020, does not include Shasta snow-wreath as a BLM sensitive species. The BLM designates a species as sensitive when it becomes at-risk and occurs on BLM land. Shasta snow-wreath is not known to occur on BLM land per the CNDDB and Shasta County parcel data.

Page	Line	Reviewer Comment	Department Response
32	33	While not formal monitoring, many of these occurrences have been subject to regular updates which have been submitted to the CNDDB. These updates include habitat condition, population size, numbers, etc., and observed threats if applicable. Review of these updates can certainly show trends and would show many of the occurrences as stable overall and in many instances the occurrence boundaries have been updated (increased) due to additional time spent and detailed work at these locations.	Text updated to indicate populations have been visited and observation data was submitted to the CNDDB.
34	5	Per the previous comment on page 21, given the proposed Shasta Dam project is inactive, is it prudent to provide analysis as if the project were proceeding? If this project isn't proceeding in the foreseeable future should the analysis include an alternative where there is no proposed enlargement and associated threats? Given this proposed project is included in the Status Review, did the analysis consider the numerous minimization and mitigation measures for snow-wreath proposed by the project if it were to move forward?	The Department considers the Shasta Dam project as an active project. A Final Supplemental Environmental Impact Statement was prepared in November 2020, indicating the project is moving forward with environmental review. Despite challenges to project implementation, the Department considers the project to raise Shasta Dam as potentially proceeding in the foreseeable future and, therefore, includes the project as a reasonable threat to the species in the Status Review. The Department reviewed the mitigation measures included in the FEIS for the project. The FEIS indicates that even with implementation of the mitigation measures, the impacts to Shasta snow-wreath would be significant and unavoidable. If Shasta snow-wreath is listed under CESA, impacts to the species would require full mitigation.

Page	Line	Reviewer Comment	Department Response
35	11	More explanation is needed here. How does the climate change model used in this analysis show snow-wreath habitat shifting upwards in elevation? The species distribution excludes higher elevation areas within its range currently, so why would it shift to higher areas? This sounds more like a climate change scenario for a species more closely linked to snowpack. The existing snow-wreath occurrences are characterized as low elevation sites in canyons along streams and other cooler-aspect slopes; all of which are within an area subject to high annual precipitation. The species does not occur in higher elevation areas within its range due to those areas having cooler average temperatures and increased instances of persistent snow. Other southeastern Klamath Ranges endemics show a similar pattern. Climate models showing warmer and wetter trends suggest the existing habitat would persist and perhaps additional areas within the species range may become suitable.	Text updated to add additional information regarding changes in habitat suitability and potential responses of Shasta snow-wreath. Since Shasta snow-wreath is found on cool aspect locations, warmer conditions may limit suitable habitat for the species. A general expectation for many species in response to climate change is that suitable habitat will shift upward in elevation in response to climate change as temperatures warm. Climate conditions similar to Shasta snow-wreath's current habitat may therefore shift to higher elevations (likely upstream).
35	14	This may work both ways, as these topographical characteristics are also providing the very refugia the species uses and considerably influences its distribution.	Text updated to add additional discussion on limitations to Shasta snow-wreath's persistence if existing habitat becomes unsuitable.
35	18	I understand this is a possible threat, as it has happened once before. That said, this is a very minimal threat because the likelihood of this happening again is very low. Besides the USFS project at Waters Gulch that may be using herbicide for weed control, there are no snow-wreath occurrences in areas subject to herbicide use. Herbicide application at the McCandless Gulch occurrence (where herbicide killed snow-wreath) is completed and the other occurrences on SPI lands are outside of areas where herbicide treatment would occur. As described, this paragraph is vague and somewhat speculative, particularly in the context of the number of occurrences where herbicide could be used. Please provide more information where this threat could actually occur.	Comment noted. Although currently herbicide is not being used at the Shasta snow-wreath populations, this has happened in the past. Weeds are going to continue to spread and future treatments could occur to control these invasions. The statements in this paragraph are meant to briefly summarize points made earlier in the document, and the Department considers the use of herbicide as a potential risk in the future, even if specific plans are not yet in place.

Page	Line	Reviewer Comment	Department Response
37	25	I suggest an expanded discussion, how will "management actions required by CESA" provide special protection to the species? Per this Status Review, the USFS owns 67 percent of the snow-wreath habitat. The USFS planning process, NEPA, and ESA do not recognize CESA-listed species on federal lands. However, snow-wreath is considered a Sensitive species by the USFS and is therefore integrated into forest planning and NEPA analyses. The greatest species threat identified in the Status Review, in terms of habitat loss, is a federal project on federal lands. Did the analysis for the Species Review consider what, if any benefit a state-listing would provide to the species considering such a listing would make no difference to the existing regulatory framework for federal agencies on federal lands?	The Department acknowledges that NEPA and ESA do not recognize CESA-listed species on federal lands. Per Section 670.1 of the California Code of Regulations, Title 14., Division 1, a species shall be listed as endangered or threatened if the Commission determines that its continued existence is in serious danger or threatened by any one or any combination of the following factors: 1. Present or threatened modification or destruction of its habitat; 2. Overexploitation; 3. Predation; 4. Competition; 5. Disease; or 6. Other natural occurrences or human-related activities. Regulatory benefit is not a requirement for the species to be recommended for listing under CESA.
38	4	Is the Status Review suggesting the existing CEQA and NEPA framework isn't working? Existing information suggests it is. Again, all we know about the species aside from seven populations found during the initial discovery and subsequent efforts is due to existing regulatory requirements. In addition to planning level information, these requirements have also resulted in on-the-ground minimization and protection measures for the species.	Comment noted. The Department acknowledges that lead agencies often disclose impacts to sensitive species during the CEQA and NEPA processes, and sometimes lead agencies mitigate for impacts to such species. Nevertheless, species that are not listed typically receive far less protection as a result of CEQA and NEPA processes than species that are listed under CESA.

38	11	There is no guarantee of additional funding by any means, per the following sentence. What can be said more definitively is that any activities around listed species occurrences become increasingly challenging and difficult, often resulting in nothing being done simply because management agencies, project proponents, or regulatory agencies are unable or unwilling to navigate the consultation process. This includes circumstances that could provide conservation benefit. A relevant example of this for snow-wreath are the administrative and legal challenges the USFS faced when proposing invasive species control and fuels reduction at the Waters Gulch snow-wreath occurrence, portions of which are being impacted by an invasive broom population. After a lengthy process to complete their NEPA documents, the proposed project was challenged due to proposed herbicide use (shown in the NEPA document to be very low risk of detrimental effects) and the project stalled as the USFS was unable to readily complete updated project planning and revised NEPA documents. A local consultancy, on behalf of the Bureau of Reclamation (BOR) who was interested in potential snow-wreath mitigation measures at the time due to the proposed Shasta Dam enlargement, worked with the USFS to revise the project and complete the NEPA documents. Sadly, the original proposed project was reduced and made less effective relative to the need for invasive species control for snow-wreath and fuels reduction due to concerns related to the initial legal challenge. Nonetheless, the project finally made it through the NEPA process and some initial on-the-ground work has been completed. The three main points here are (1) the USFS itself struggled to complete the NEPA process, (2) the project stalled upon legal challenge and created additional delays, (3) an outside interest had to be the lead, provide funding, and bring the project to completion, otherwise the project would unlikely have been approved, or it would certainly have taken much longer. All of this happened for a non-listed species in a situation where the threat from invasive species is painfully obvious even to an untrained observer – while the USFS wouldn't recognize a state listing anyway, how would this possibly have been made easier if the species were state-listed? This was the single time the USFS directly dealt with this species on a project (besides trail maintenance at Waters Gulch and a small prescribed fire at Jones Valley). I can't see how a state listing would make the USFS, who owns 67% of the occupied snow-wreath habitat per this Status Review, more prone to attempt management activities.	Comment noted. The status review indicates that listing under CESA may increase the allocation of funding but does not suggest that funding is guaranteed if the species is listed under CESA.

Page	Line	Reviewer Comment	Department Response
38	28	I understand these are CDFW recommendations, but inevitably they provide groundwork for recovery actions. Please explain why these measures cannot be accomplished currently or if that has even been discussed. Does the listing petition describe whether attempts have been made to discuss or implement such measures and failure to do so has created an impediment to proposed conservation measures? Also, please explain why it's implied a species must be listed in order for these actions to occur, and how this affected the analysis for the Status Review. Did the Status Review consider if these actions were enacted whether the recommendation to list as threatened would still apply? How would these actions be enacted if the agency that owns 67% of the snow-wreath habitat, yet doesn't recognize a state-listed species, is not engaged in these processes? Will the USFS commit to these measures? While conducting work for the proposed Shasta Dam enlargement project a technical group was formed to initiate many of the items listed below with the goal of creating a snow-wreath management plan. The group initially included the CDFW, USFS, USFWS, and the BOR (via their representative). Other stakeholders would have also been invited if the proposed project had continued. The primary nexus was a management plan completed in the late-2000s by the NPS, USFWS, Caltrans, and CDFW for *Puccinellia howellii*, which is known from a single location located along Clear Creek and Highway 299W, near Whiskeytown Lake, several miles southwest of the snow-wreath range. This plan and accompanying implementation measures prevented the species from becoming listed. That plan served as a model for the snow-wreath group and was considered a way to bring all interested parties together and perform effective management without the complications of trying to do so for a listed species. If a plan can be implemented for a species with a single occurrence adjacent to a state highway, why can't one be completed for a species with numerous occurrences spread over a relatively large area? A similar plan could be developed by the USFS focusing on federal lands to address the federal petition to list snow-wreath under the ESA, such as the plan developed by the Klamath National Forest *for Calochortus persistens*, which was completed to avoid federal listing of this state-listed plant. It seems that any answers regarding conservation issues for this species must include the USFS and they must play an engaged, active role. The listing petition fails to describe whether the USFS is unable to do so, and if	The Fish and Game Code (section 2074.6) requires the Department to recommend management activities and other recommendations for recovery of the species in its status review. Many of the recommendations could probably be accomplished regardless of whether the species becomes listed under CESA or not. There is no requirement for the Department to describe why these management recommendations cannot be accomplished currently, or the likelihood that they will be implemented at all. Per Section 670.1 of the California Code of Regulations, Title 14., Division 1, a species shall be listed as endangered or threatened if the Commission determines that its continued existence is in serious danger or threatened by any one or any combination of the following factors: 1. Present or threatened modification or destruction of its habitat; 2. Overexploitation; 3. Predation; 4. Competition; 5. Disease; or 6. Other natural occurrences or human-related activities. Regulatory benefit is not a requirement for the species to be recommended for listing under CESA.

Page	Line	Reviewer Comment	Department Response
		discussions regarding the matter have even occurred. The Status Review lacks details describing how a state listing changes any of those issues and what conservation or regulatory benefit would occur, that is not already occurring, on the non-federal snow-wreath issue areas.	Many of these are open ended questions and comments and are noted.
Appendix A, row for CNDDB Occurrence #3		Small detail, but this is actually French broom, a correction has been submitted to the CNDDB.	Text updated to reflect correct information.
Appendix A, row for CNDDB Occurrence #12		Why the description here of the nuances behind the mapping? Each occurrence has nuances behind the mapped boundaries, accuracy, the "CNDDB buffer issue," and even completeness (e.g., the Curl Creek occurrence is not fully mapped). This isn't explained nor applied in the Status Review, yet appears here to suggest the occurrence may be smaller. Regarding ramet population size; there has never been a complete population estimate of this occurrence conducted at the same time, rather the estimates provided represent only the portions of the occurrence recorded for the particular data collecting event at that time for which the data was provided to the CNDDB. Also note the plant material collected for the DeWoody et al. (2012) study was from the lower portion of the occurrence near the Stein Creek/Shasta Lake confluence, as that was all known at the time regarding the extent of the occurrence, and did not include the portions of the occurrence in the upper watershed.	Text updated to remove the additional description in the notes regarding the mapping nuances since it is indicated in the footnotes. The footnotes also indicate that some of the ramet estimates are from partial surveys or from surveying a portion of the element occurrence. Comments noted.
Appendix A, row for CNDDB Occurrence #22		This reads as past tense given the timing of the original record submittal. The timber harvest and subsequent reforestation efforts here are completed at this location. The plants were protected in a WLPZ and HRA. Updated records have been submitted to the CNDDB, herbarium specimens have been collected, and the site was included among several shown to CDFW during April 2021.	Text updated to reflect the plants are protected in an HRA and a WLPZ. Other comments noted.
Appendix A, row for CNDDB Occurrence #23		See previous comments and supplemental information provided to CDFW regarding this occurrence. The timber harvest did not occur as planned and only a small portion was subject to selected tree removal.	Text updated to include that timber harvest activities occurred along the edge of the population.

Page	Line	Reviewer Comment	Department Response
Overall comment		This Status Review does a good job describing the species discovery, biology, and general distribution. The Review also provides context for the primary ecological characteristics of the species; a relict taxon consisting of relatively few populations, low genetic diversity within populations, high differentiation between populations, and limited dispersal capability. However, the Status Review also has shortcomings that I believe start with the listing petition. The petition presents numerous potential threats to the species, but besides the Shasta Dam project, lacks substantial evidence that these threats previously, currently, or in the foreseeable future (i.e., degree and immediacy) result in species impacts warranting listing. The Status Review includes similar speculative information regarding these potential threats and lacks detailed description of how the existing regulatory framework is not providing adequate species protection when evidence suggests otherwise. These issues in turn do not provide the clarity and foundation I believe necessary to support a comprehensive evaluation and Status Review.	Comment noted. Responses provided per specific comments listed above.
Overall comment		There seems to be a disconnect in the listing petition and this Status Review between a potential threat and the likelihood of that threat actually happening. Several of the topics presented as threats are generalized and lack evidence that they are occurring or will occur in the foreseeable future. With that as context, when I look at each snow-wreath occurrence and potential threats – what is currently or in the future going to become an issue at that location? Then when I read the Scientific Determinations in the Status Review, aside from the dam enlargement project, we are left evaluating very minor impacts from THPs, and no overexploitation, predation, competition, or disease. Then in the Other Natural Occurrences or Human-related Activities section we are left evaluating climate change or other disturbances (with no mention of what "other disturbances" are…), and a very unlikely threat from herbicides. While snow-wreath is a relict with relatively few populations, low genetic diversity and high differentiation, and limited dispersal capability, the conclusions presented lack compelling evidence that there are actually on-going threats or threats that will occur in the foreseeable future that would be changed by a state listing. I would like to see why potential threats to the species (supposedly) can't be addressed by conservation measures afforded under the existing regulatory framework and how a state listing would change any of those circumstances for the benefit of the species.	Comment noted. Responses provided per specific comments listed above.

Page	Line	Reviewer Comment	Department Response
Overall comment		Finally, per previous comments, the issue of the Shasta Dam project and how the project factors into this analysis needs further refinement. If the project isn't moving forward, why does this Status Review assume otherwise? If it is not moving forward but also not conclusively dead, how does the Status Review and potential CESA listing deal with a "looming" potential threat that may never occur?	Comment noted. Responses provided per specific comments listed above.

State of California – Natural Resources Agency
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GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

Date: 8/16/2021

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SUBJECT: STATUS REVIEW OF SHASTA SNOW-WREATH; CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW

Dear Jane Van Susteren:

Thank you for agreeing to serve as a scientific peer reviewer of the California Department of Fish and Wildlife (Department) Status Review of Shasta Snow-wreath (*Neviusia cliftonii*) (Status Review). A draft of the Department's Status Review, dated August 16, 2021, is included with this letter. The Department seeks your expert analysis and input regarding the scientific validity of the Status Review and its assessment of the status of Shasta snow-wreath in California. The Department would appreciate receiving your peer review comments on or before September 10, 2021.

The Department seeks your scientific peer review as part of formal proceedings pending before the Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). The Commission is a constitutionally established entity distinct from the Department, exercising exclusive statutory authority under CESA to list species as endangered or threatened (Fish & G. Code, § 2070). The Department serves in an advisory capacity during CESA listing proceedings, charged by the Fish and Game Code to provide a report to the Commission based on the best scientific information available indicating whether recommendations to list species are warranted and recommending actions for recovery of those species (Fish & G. Code, § 2074.6).

On September 30, 2019, the Commission received a petition to list Shasta snow-wreath as an endangered species under CESA. On May 1, 2020, the Commission published findings formally designating Shasta snow-wreath as a candidate species for endangered status under CESA while a status review was completed by the Department. Shasta snow-wreath is currently protected under CESA in California in that capacity.

The peer review draft of the Department's Status Review forwarded to you today reflects the Department's effort to identify and analyze the best scientific information available regarding the status of Shasta snow-wreath in California. At this time, the

Department believes that the best available science indicates that listing the species as threatened under CESA is warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop and finalize its recommendation to the Commission as required by the Fish and Game Code. Our expected recommendation to the Commission at this point may change following peer review input.

We ask you to focus your peer review on the best scientific information available regarding the status of Shasta snow-wreath in California. As with our own effort to date, your peer review of the science and analysis regarding each of the population and life history categories prescribed in CESA are particularly important (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A)) (i.e., present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) as well as whether the information indicates, in your opinion, that Shasta snow-wreath, although not currently faced with extinction, is likely to become an endangered species in the foreseeable future in the absence of protection by CESA. Please note that the Department releases this Status Review to you solely as part of the peer review process, and it is not yet public.

A PDF version of the Status Review is included with this letter. For ease of review, and so we may respond to your comments individually, please submit your comments in list form by page and line number. Please submit your comments electronically to Cherilyn Burton, Senior Environmental Scientist (Specialist) at cherilyn.burton@wildlife.ca.gov. Cherilyn Burton may also be reached at (916) 206-0411. If there is anything the Department can do to facilitate your review, please let us know.

Following receipt and consideration of peer review comments, the Department will prepare and submit its final Status Review and recommendation to the Commission. Your comments and the Department's response to each comment will be included in an appendix to the Department's Status Review. After a minimum 30-day public review period and prior to making their decision, the Commission will consider: the Department's recommendation to list Shasta snow-wreath, the Department's Status Review with peer reviewer comments, and public testimony received during a regularly scheduled Commission meeting.

Thank you again for your contribution to the Status Review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

DocuSigned by:
Jeff Drongesen
37E732799B3C452...

Jeff Drongesen, Branch Chief
Habitat Conservation Planning Branch

Enclosures

ec: California Department of Fish and Wildlife

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September 3, 2021

Cherilyn Burton,
Native Plant Program
California Department of Fish & Wildlife
Habitat Conservation Planning Branch

Dear Cherilyn,

In my opinion the information in the Draft Status Review indicates that Shasta snow-wreath, although not currently faced with extinction, is likely to become an endangered species in the foreseeable future in the absence of protection by CESA. My notes on minor issues or questions follow.

Page v, line 35. (Page 20, line 24, 27, and 33. Page 21, line 5. Page 35, line 6, 36) Extinction debt definition: the original definition of "extinction debt" refers to undefined loss of diversity due to loss of habitat. It is currently also used to refer to a specific taxon that will not be able to recover. Advise clarifying that the latter definition is being used.

Page 11, line 11-17. Vegetative reproduction and diversity of alleles within a population. Advise clarifying why population-level diversity is important if no sexual reproduction has been observed.

Page 14, line 30. This is the "Geology and Soils" section, but no details on soil characteristics are provided. Suggest either renaming the section or providing soils data.

Page 19, lines 30-33. Seed viability. Note if seeds have been collected under California Plant Rescue and whether basic viability tests have been conducted. Are the seeds respiring? What are the results of cutting tests? What attempts have been made to germinate seeds? (These details may be in the Ertter and Shevock paper but I couldn't track it down.)

Page 39, line 24. Suggest adding population biology studies to determine characteristics about historic diversity within the species, and to define whether present diversity is relictual or novel.

Thank you for the opportunity to review this very special species, and for your excellent evaluation. Please let me know if you have any questions about my comments.

Yours truly,

-Jane Van Susteren

Peer Review Comments from Jane Van Susteren on the Shasta Snow-wreath (*Neviusia cliftonii*) Status Review and California Department of Fish and Wildlife Responses

Page	Line	Reviewer Comment	Department Response
v	35	Extinction debt definition: the original definition of "extinction debt" refers to undefined loss of diversity due to loss of habitat. It is currently also used to refer to a specific taxon that will not be able to recover. Advise clarifying that the latter definition is being used.	Text updated to clarify that extinction debt refers to the future extinction of a species due to past disturbances from which it cannot recover.
11	11-17	Vegetative reproduction and diversity of alleles within a population. Advise clarifying why population-level diversity is important if no sexual reproduction has been observed.	Text updated to indicate low levels of genetic diversity are a potential result of lack of sexual reproduction.
14	30	This is the "Geology and Soils" section, but no details on soil characteristics are provided. Suggest either renaming the section or providing soils data.	Text updated to indicate plants are found on non-limestone derived soils. Specific descriptions of soil mapping units was not added.
19	30-33	Seed viability. Note if seeds have been collected under California Plant Rescue and whether basic viability tests have been conducted. Are the seeds respiring? What are the results of cutting tests? What attempts have been made to germinate seeds? (These details may be in the Ertter and Shevock paper but I couldn't track it down.)	Text updated to include information about seed germination effort by UC Botanical Garden as reported in Ertter and Shevock's 1993 paper. No seeds have been collected under the California Plant Rescue. There is one accession of Shasta snow-wreath seeds consisting of 53 seeds collected in 1992 and stored at the California Botanic Garden in Claremont. Germination or viability tests have not been conducted on this collection because the collection is so small. This information was not added to the Status Review because it does not add to the analysis.

Page	Line	Reviewer Comment	Department Response
39	24	Suggest adding population biology studies to determine characteristics about historic diversity within the species, and to define whether present diversity is relictual or novel.	Text updated to add this recommendation.

State of California
Natural Resources Agency
Department of Fish and Wildlife

REPORT TO THE FISH AND GAME COMMISSION

STATUS REVIEW OF SHASTA SNOW-WREATH (*Neviusia cliftonii*)

Peer Review Draft: August 16, 2021

Shasta snow-wreath (*Neviusia cliftonii*), CDFW photo by Cherilyn Burton

Charlton H. Bonham, Director
Department of Fish and Wildlife

TABLE OF CONTENTS

LIST OF FIGURES iii
LIST OF TABLES iii
LIST OF APPENDICES iii
LIST OF ABBREVIATIONS, ACRONYMS AND TERMS iv
EXECUTIVE SUMMARY v
INTRODUCTION 1
Petition History 1
Status Review 2
Notification, Information Received, and Peer Review 3
BIOLOGY 3
Species Description 3
Taxonomy 4
Range and Distribution 6
Life History 8
Genetics 9
Similar-looking Plants 12
Habitat that may be Essential to the Continued Existence of the Species 12
Vegetation Communities 14
Geology and Soils 14
Climate, Hydrology, and other factors 16
ABUNDANCE AND POPULATION TRENDS 18
FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE 19
Genetics, Reproductive Challenges, and Small Population Size 19
Habitat Modification and Destruction 21
Invasive Species 26
Climate Change 27
Altered Fire Regimes 28
REGULATORY AND LISTING STATUS 29
Federal 29
State 29

Natural Heritage Program Ranking 30
California Rare Plant Rank 31
EXISTING MANAGEMENT EFFORTS 31
National Forest Service Lands 31
Monitoring 32
SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF SHASTA SNOW-WREATH IN CALIFORNIA 32
Present or Threatened Modification or Destruction of Habitat 33
Overexploitation 34
Predation 34
Competition 34
Disease 34
Other Natural Occurrences or Human-related Activities 34
SUMMARY OF KEY FINDINGS 35
RECOMMENDATION FOR PETITIONED ACTION 36
PROTECTION AFFORDED BY LISTING 37
MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES 38
ACKNOWLEDGEMENTS 39
LITERATURE CITED 39
Literature 39
Personal Communication 49

LIST OF FIGURES

Figure 1. Photographs of Shasta Snow-wreath (*Neviusia cliftonii*) 5
Figure 2. Distribution of Shasta Snow-wreath Populations 7
Figure 3. Land Ownership of Shasta Snow-wreath Populations 8
Figure 4. Relationship of Ramets to Genets 10
Figure 5. Shasta Snow-wreath and Similar Looking Species 13
Figure 6. Shasta Snow-wreath Habitat 15
Figure 7. Shasta Snow-wreath Population at Waters Gulch 25
Figure 8. Invasive Species. 27

LIST OF TABLES

Table 1. Status Review Peer Reviewers 3
Table 2. Number of Genets Compared to Ramets at Shasta Snow-wreath Populations Sampled in DeWoody et al. (2012). 11
Table 3. Direct Impacts to Shasta Snow-wreath Populations from the Proposed Project to Raise Shasta Dam 22

LIST OF APPENDICES

APPENDIX A. Summary of Shasta Snow-wreath Populations and Threats
APPENDIX B. Comments from Affected and Interested Parties on the Petitioned Action
APPENDIX C. External Peer Review Invitation Letters and Comments from Peer Reviewers on the Shasta Snow-wreath Status Review Report

LIST OF ABBREVIATIONS, ACRONYMS AND TERMS

CEQA – California Environmental Quality Act

CESA – California Endangered Species Act

CNDDB – California Natural Diversity Database

CNPS – California Native Plant Society

Commission – California Fish and Game Commission

CRPR – California Rare Plant Rank

Department – California Department of Fish and Wildlife

Occurrence – CNDDB Element Occurrence

Evaluation – Evaluation of a Petition from Kathleen Roche to List Shasta Snow-Wreath as Endangered under the California Endangered Species Act

Id. – "the same"

NEPA – National Environmental Policy Act

Petition - Petition to the State of California Fish and Game Commission to List the Shasta Snow-wreath (*Neviusia cliftonii*) as Endangered under the California Endangered Species Act, dated September 30, 2019

SPI – Sierra Pacific Industries

Status Review – Status Review of Shasta Snow-wreath (*Neviusia cliftonii*)

subsp. – Subspecies

var. – Variety

EXECUTIVE SUMMARY

This Status Review of Shasta Snow-wreath (*Neviusia cliftonii*) (Status Review) has been prepared by the California Department of Fish and Wildlife (Department) for the California Fish and Game Commission (Commission) pursuant to the requirements of the California Endangered Species Act (CESA). This Status Review has been independently reviewed by scientific peers and is based upon the best scientific information available to the Department.

Shasta snow-wreath is a deciduous shrub in the rose family (Rosaceae) that was first discovered in 1992. Shasta snow-wreath is known from 26 populations in the eastern Klamath Ranges in Shasta County, California, near Shasta Lake. Shasta snow-wreath grows primarily in riparian areas in the dense understory of shady montane hardwood-conifer and ponderosa pine forests, and is also found in foothill pine-blue oak woodland habitat. Shasta snow-wreath populations occur on limestone and a variety of substrates derived from metamorphic and igneous formations, such as shale, mudstone, and greenstone.

Little information is available on Shasta snow-wreath population trends, but it is presumed that populations were larger and more connected prior to the construction of Shasta Dam and the filling of Shasta Lake in the 1940s. Shasta snow-wreath is threatened by competition with aggressive invasive plant species such as Himalayan blackberry and Scotch broom. Shasta snow-wreath is also limited in its ability to reproduce, since it appears to be restricted to vegetative reproduction and no seedlings of this species have been observed. Shasta snow-wreath has very low genetic diversity within populations, which is typical of species that reproduce by vegetative means, and populations seemingly comprised of hundreds to thousands of plants could actually be small populations comprised of clones of only a few genetically distinct individuals. Small populations and populations with low genetic diversity are vulnerable to extirpation due to changing environmental conditions and stochastic (chance) events.

Populations of Shasta snow-wreath are also threatened by the proposed project to raise the height of Shasta Dam, which would raise the water level of Shasta Lake by 6.25 m (20.5 ft), resulting in impacts to portions of half of the known populations. Shasta snow-wreath may also be affected by climate change, compounding the risk of extirpation faced by small populations and populations with low genetic diversity. Shasta snow-wreath is considered a relict species, or a “living fossil” remaining from a formerly more widespread group whose close relatives have gone extinct, and the species may also face a phenomenon called extinction debt. Extinction debt refers to the future extinction of a species due to past disturbances. It can take a considerable amount of time for a

population or species to disappear following disturbances such as habitat loss or degradation.

The information available to the Department regarding the status of Shasta snow-wreath indicates that there are significant threats to the continued existence of the species. In addition to evaluating whether the petitioned action to list the species as endangered is warranted, the Department also considered whether listing as threatened under CESA is warranted. Based on review of the best available scientific information, the Department finds that Shasta snow-wreath, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by CESA. The Department recommends that listing Shasta snow-wreath as threatened under CESA is warranted at this time.

INTRODUCTION

This Status Review addresses Shasta snow-wreath (*Neviusia cliftonii* Shevock, Ertter & D.W. Taylor).

Petition History

On September 30, 2019, the Commission received a petition (Petition) from Ms. Kathleen Roche to list Shasta snow-wreath as an endangered species pursuant to CESA (Fish & G. Code, § 2050 *et seq.*).

On October 10, 2019, the Commission referred the Petition to the Department for evaluation.

On November 6, 2019, pursuant to Fish and Game Code Section 2073.5, the Department requested a 30-day extension of time to complete its evaluation report.

On November 22, 2019, as required by Fish and Game Code section 2073.3, the Commission published notice of receipt of the Petition in the California Regulatory Notice Register. (Cal. Reg. Notice Register 2019, No. 47-Z, p.1592, https://oal.ca.gov/wp-content/uploads/sites/166/2019/11/2019-Notice-Register-Number-47-Z-November-22-2019.pdf).

On February 3, 2020, the Department provided the Commission with a report, "Evaluation of a Petition from Kathleen Roche to List Shasta Snow-Wreath as Endangered Under the California Endangered Species Act" (Evaluation). Based upon the information contained in the Petition, the Department concluded, pursuant to Fish and Game Code, section 2073.5, subdivision (a), that sufficient information exists to indicate that the petitioned action may be warranted and recommended to the Commission that the Petition should be accepted and considered.

On April 16, 2020, at its scheduled public meeting via teleconference, the Commission considered the Petition, the Department's Evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for consideration.

Subsequently, on May 1, 2020, the Commission published its Notice of Findings for Shasta snow-wreath in the California Regulatory Notice Register, designating Shasta snow-wreath as a candidate species. (Cal. Reg. Notice Register 2020, No. 18-Z, p. 692, https://oal.ca.gov/wp-content/uploads/sites/166/2020/05/2020-Notice-Register-Number-18-Z-May-1-2020.pdf).

The Department promptly commenced its review of the status of the species as required by Fish and Game Code section 2074.6. On April 14, 2021, the Commission approved the Department's request for a six-month extension to facilitate external peer review and complete the status review, which has now concluded with this Status Review document.

Status Review

Pursuant to Fish and Game Code section 2074.6 and California Code of Regulations, title 14, section 670.1, the Department has prepared this Status Review to indicate whether the petitioned action to list Shasta snow-wreath under the California Endangered Species Act (CESA) is warranted. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species is one that "although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [CESA]" (*Id.*, § 2067).

Using the best scientific information available to the Department, this Status Review includes information on each of the following components pursuant to section 2072.3 of the Fish and Game Code, and section 670.1 of Title 14 of the California Code of Regulations: population trend(s); range; distribution; abundance; life history; factors affecting the species' ability to survive and reproduce; the degree and immediacy of threats; the impact of existing management efforts; the availability and sources of information; habitat that may be essential for the continued existence of the species; and the Department's recommendations for future management activities and other recovery measures to conserve, protect, and enhance the species.

Specifically, this Status Review analyzes the best available science in order to recommend whether the continued existence of Shasta snow-wreath throughout all or a significant portion of its range is in serious danger or is threatened by one or a combination of the following factors: present or threatened modification or destruction of its habitat; overexploitation; predation; competition; disease; or other natural occurrences or human-related activities. (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A).).

This Status Review was prepared by Cherilyn Burton in the Department's Habitat Conservation Planning Branch, Native Plant Program.

Notification, Information Received, and Peer Review

Following the Commission's action to designate Shasta snow-wreath as a candidate species, the Department notified affected and interested parties and solicited data and comments on the petitioned action pursuant to Fish and Game Code section 2074.4 (see also Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)). Comments on the petitioned action were invited via a general notification dated July 7, 2020, and a tribal notification dated July 14, 2020. These notifications were distributed to tribes, owners and managers of lands supporting Shasta snow-wreath populations, and other interested individuals and organizations. The Department received one comment in response to the general notification and one e-mail in response to the tribal notification. All responses received are included in Appendix B to this report.

Pursuant to Fish and Game Code section 2074.6, the review process included independent peer review of the draft status review by persons in the scientific and academic community acknowledged to be experts on Shasta snow-wreath and possessing the knowledge and expertise to critique the scientific validity of the Status Review. Appendix C contains the specific input provided to the Department by the individual peer reviewers, the Department's written response to the input, and any amendments made to the draft Status Review report (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)). Independent experts that reviewed the Status Review are listed in Table 1, below.

Table 1. Status Review Peer Reviewers

Name	Affiliation

BIOLOGY

Species Description

Shasta snow-wreath is a deciduous understory shrub that grows to a height of approximately 2.5 m (8.2 ft) (Shevock et al. 1992). It has erect, slender branches that are rarely greater than 1 cm (0.4 in) in diameter. The bark of Shasta snow-wreath is grayish near the base of the plant and reddish brown above, exfoliating in strips (Shevock et al. 1992). Its oval to heart-shaped, coarsely-toothed, bright green leaves are arranged alternately along the slender stems and are sparsely covered with stiff, straight, appressed hairs that are approximately 0.4 mm (0.02 in) long (Shevock et al. 1992; Heikens and Ertter 2012). The inflorescence of Shasta snow-wreath is generally

comprised of three to five flowers arranged in an umbel-like cluster, meaning each pedicel (i.e., flower stalk) seemingly radiates from a common point of attachment without an evident axis or branches. The pedicels are 1-3 cm (0.4-1.2 in) long and are very slender (approximately 0.3 mm wide). Shasta snow-wreath flowers are bisexual, which means they contain both male and female organs in the same flower. Each flower has approximately 50 showy white stamens (male reproductive structures) that are each about 4-5 mm (0.2 in) long, and 2 to 6 pistils (female reproductive structures), each with an ovary that is densely covered in white stiff, straight, appressed hairs. There are sometimes one, two, or rarely three white petals present on the flowers that are 4-6 mm (0.2 in) long, but the petals are usually absent (Shevock et al. 1992) (see Figure 1). Shasta snow-wreath flowers have 5 to 6 oval sepals that are 4-6 mm (0.2 in) long and are irregularly few-toothed (Shevock et al. 1992; Heikens and Ertter 2012). The fruit is an achene, which is a dry, indehiscent (not splitting open), one-seeded fruit from a one-chambered ovary in which the fruit wall is free from the seed.

Taxonomy

Shasta snow-wreath was first discovered and described in 1992 and was added to the genus *Neviusia*, which contains one other extant species, Alabama snow-wreath (*Neviusia alabamensis* A. Gray) (Shevock et al. 1992; Taylor 1993; Heikens and Ertter 2012). The genus *Neviusia* is in the rose family (Rosaceae), which is a large family containing 110 genera and approximately 3000 species worldwide (Potter and Ertter 2014). *Neviusia* is in the Kerrieae tribe of the rose family, which consists of *Neviusia* and three other genera (*Coleogyne*, *Kerria*, and *Rhodotypos*) that each are comprised of just one species (Brouillet 1993; Potter et al. 2007). The four genera are highly distinct morphologically and are regarded as ancient relicts (Brouillet 1993; Stebbins 1993; Potter et al. 2007). A relict is a species or a group of species remaining from a large group that is mainly extinct (Grandcolas et al. 2014). Relict species, such as Shasta snow-wreath, are ranked of high value for conservation biology, since they are the only surviving representatives of a formerly more widespread group whose close relatives have gone extinct, and they are often regarded as “living fossils” or remnants of old times (Grandcolas et al. 2014).

Alabama snow-wreath occurs in several disjunct populations in the southeastern United States and is considered rare throughout its highly restricted range (Long 1989; NatureServe 2020). Both species of *Neviusia* are considered relict species descended from a formerly widespread genus, and fossil evidence from Southern British Columbia supports the ancient origin of the genus (DeVore et al. 2004).

(a)

(b)

Figure 1. Photographs of Shasta snow-wreath (*Neviusia cliftonii*). (a) Shasta snow-wreath thicket of many stems (ramets). (b) Shasta snow-wreath flowers.

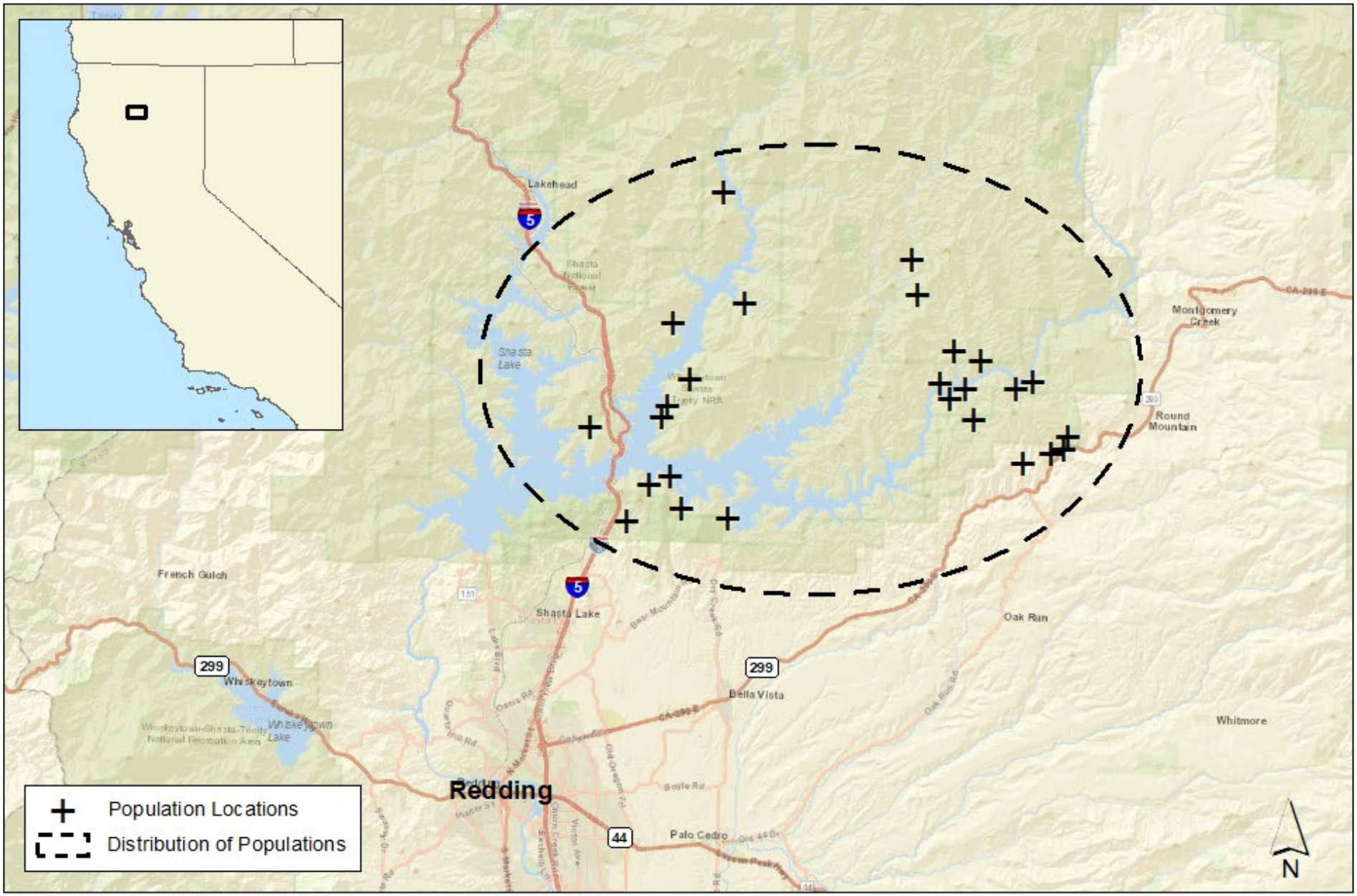
Range and Distribution

Range is the general geographical area where an organism occurs. For purposes of CESA and this Status Review, the range of a species is strictly its California range (*Cal. Forestry Assn. v. Cal. Fish and Game Com*. (2007) 156 Cal.App.4th 1535, 1551). Distribution refers to actual sites where individuals and populations of the species occur within the species' range.

Shasta snow-wreath occurs only in California in the eastern Klamath Ranges in Shasta County at elevations from 328 to 540 meters (1075 to 1772 feet) (CNDDB 2021). The total range covers approximately 650 square kilometers (250 square miles) (NatureServe 2020). All known populations of Shasta snow-wreath are in the vicinity of Shasta Lake, north of the city of Redding (see Figure 2) (CNDDB 2021), and are found within the Cow Creek, McCloud River, Pit River, Sacramento River, and Squaw Creek watersheds (Jules et al. 2017).

As mentioned above in the Taxonomy section, Shasta snow-wreath is considered a relict species descended from a formerly widespread genus (Shevock et al. 1992; Ertter 1993; DeVore et al. 2004, 2005). Relict species arise when much of a widespread population becomes extinct, leaving behind small, isolated patches. The remaining patches of the population evolve in isolation into distinct species with unique characters (DeVore et al. 2005). Fossil evidence of a closely related plant species that is now extinct (*Neviusia dunthornei* DeVore, Moore, Pigg & Wehr) from the Pacific Northwest Eocene flora (56 to 33.9 million years ago) suggests that Shasta snow-wreath's range may have once extended as far north as British Columbia, Canada (DeVore et al. 2004, 2005; DeVore and Pigg 2007).

The current distribution of Shasta snow-wreath is documented in the California Natural Diversity Database (CNDDB). The CNDDB documents plant taxa, animal taxa, and natural communities that are of conservation concern within California and refers to these taxa as "elements." An "element occurrence" is a location record for a site which contains an individual, population, nest site, den, or stand of a special status element. Populations, individuals, or colonies that are located within 0.4 km (0.25 mi) of each other generally constitute a single element occurrence, sometimes with multiple "parts" (Bittman 2001). The CNDDB records for Shasta snow-wreath were updated in June 2020. There are currently 26 documented element occurrences of Shasta snow-wreath in the CNDDB, which will be referred to as "populations" throughout this Status Review. Sometimes an element occurrence is subsumed within another element occurrence as additional information is collected, and this has occurred for Shasta snow-wreath. Thus, former element occurrences 4 and 13 are no longer separate entities in the CNDDB, and there are currently occurrence numbers up to 28 (element occurrence numbers for a given species are never reassigned). See the table in Appendix A of this Status



Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,

Figure 2. Distribution of Shasta Snow-wreath Populations

California Department of Fish and Wildlife
Status Review of Shasta Snow-wreath (*Neviusia cliftonii*)

Review for occurrence information. The distribution of Shasta snow-wreath populations is shown on Figure 2, above. Using available population area estimates, Shasta snow-wreath populations cover an area of at least 106 ha (262 ac), and the majority of the occupied areas are owned by the U.S. Forest Service (see Figure 3, below). Data on area occupied was not available for all populations of Shasta snow-wreath.

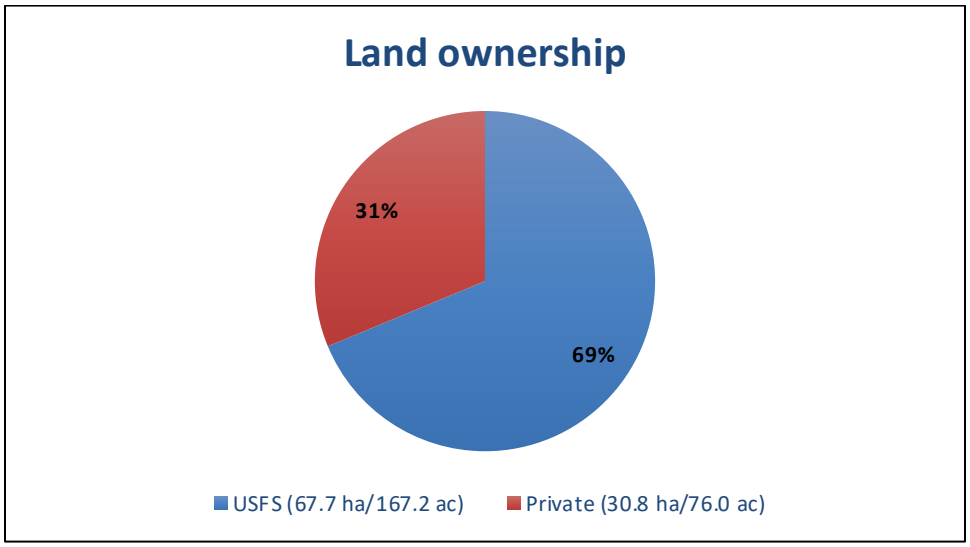


Figure 3. Land Ownership of Shasta Snow-wreath Populations
Area occupied by Shasta-snow wreath using available population data. Some populations are not included in these estimates because the information was not available.

Life History

Shasta snow-wreath is a deciduous shrub that produces new leaves in the spring, generally flowers from April to May, and sheds its leaves in the fall (Heikens and Ertter 2012). The life history and ecology of Shasta snow-wreath has not been well-studied, and little information exists on the basic demography of this species or its response to common disturbances such as fire and herbivory (Jules et al. 2017). Little is known about the reproductive biology of Shasta snow-wreath, its life-cycle stages, time to maturity, or longevity of individual plants, but the available data suggests individuals are likely long-lived (DeWoody et al. 2012). It is unknown if Shasta snow-wreath is insect- or wind-pollinated. No pollinators have ever been documented and the blossoms lack detectable scent (Ertter and Shevock 1993; Shevock 1993; Lindstrand et al. 2020), although CDFW staff observed an iridescent blue-green beetle on an inflorescence at CNDDB element occurrence 1 in May 2010. Shasta snow-wreath produces fruits called achenes (dry, one-seeded fruits), but the viability of any seeds is unknown. It is not known if the seeds are produced from selfing (fertilization by pollen from the same plant) or from cross-pollination (fertilization by pollen from another plant). No seedlings of Shasta snow-wreath have been observed germinating in the wild, and germination

attempts in controlled settings have been unsuccessful (Ertter and Shevock 1993; Stebbins 1993; Lindstrand et al. 2020). It is unknown if Shasta snow-wreath can reproduce by seed or what the limiting factors are for seed germination, but it is presumed that reproduction by seed is absent or exceedingly rare. Although Shasta snow-wreath occasionally produces seeds, apparently from sexual reproduction, it is thought to reproduce primarily vegetatively (i.e., asexually), with stems arising from the root system to form large thickets of clones (Ertter and Shevock 1993; Jules et al. 2017). The closely related Alabama snow-wreath has low seed viability and is known to reproduce only by vegetative spread (Freiley 1994).

Genetics

Species that reproduce primarily by vegetative means, such as Shasta snow-wreath, often exhibit very low genetic variability within populations (DeWoody et al. 2012). In addition, there is greater potential for populations to be genetically distinct from each other since species reproducing vegetatively generally have poor dispersal capability (Ellstrand and Roose 1987; Silvertown 2008). For clonal species, the term “genet” is used to describe a group of genetically identical individuals that all originate vegetatively from a single ancestor. Each unit (seemingly individual plant) is referred to as a “ramet”. Above ground, these ramets most often appear to be distinct individuals, but they may all be clones of the same genet (see Figure 4).

DeWoody et al. (2012) conducted a genetics study to investigate the number of genets in Shasta snow-wreath populations, identified by allelic diversity at 17 loci. In this study, 21 subpopulations from 17 Shasta snow-wreath populations (CNDDB occurrences) were sampled and genotyped (DeWoody et al. 2012; CNDDB 2021). The results of the study indicated that five subpopulations of Shasta snow-wreath were composed of a single genet each. The average number of genets per subpopulation was 3.14, and the maximum number of genets identified in a subpopulation was 15 (Table 2). Some genotypes occurred in multiple subpopulations (DeWoody et al. 2012). The lack of genetic variation found within the populations is consistent with the typical vegetative reproduction of this species (DeWoody et al. 2012).

The study also found that populations of Shasta snow-wreath have high genetic differentiation between populations, with 85 percent of the genetic variance distributed among the populations. The F_{ST} (the level of genetic differentiation) between populations was 0.8 in the study, which DeWoody et al. (2012) indicate is remarkably high. The high genetic differentiation between Shasta snow-wreath populations is typical for plants with limited seed or pollen dispersal mechanisms, and also indicates limited gene flow among populations (DeWoody et al. 2012). Diversity in Shasta snow-wreath is greater than that reported for the closely related congener, Alabama snow-

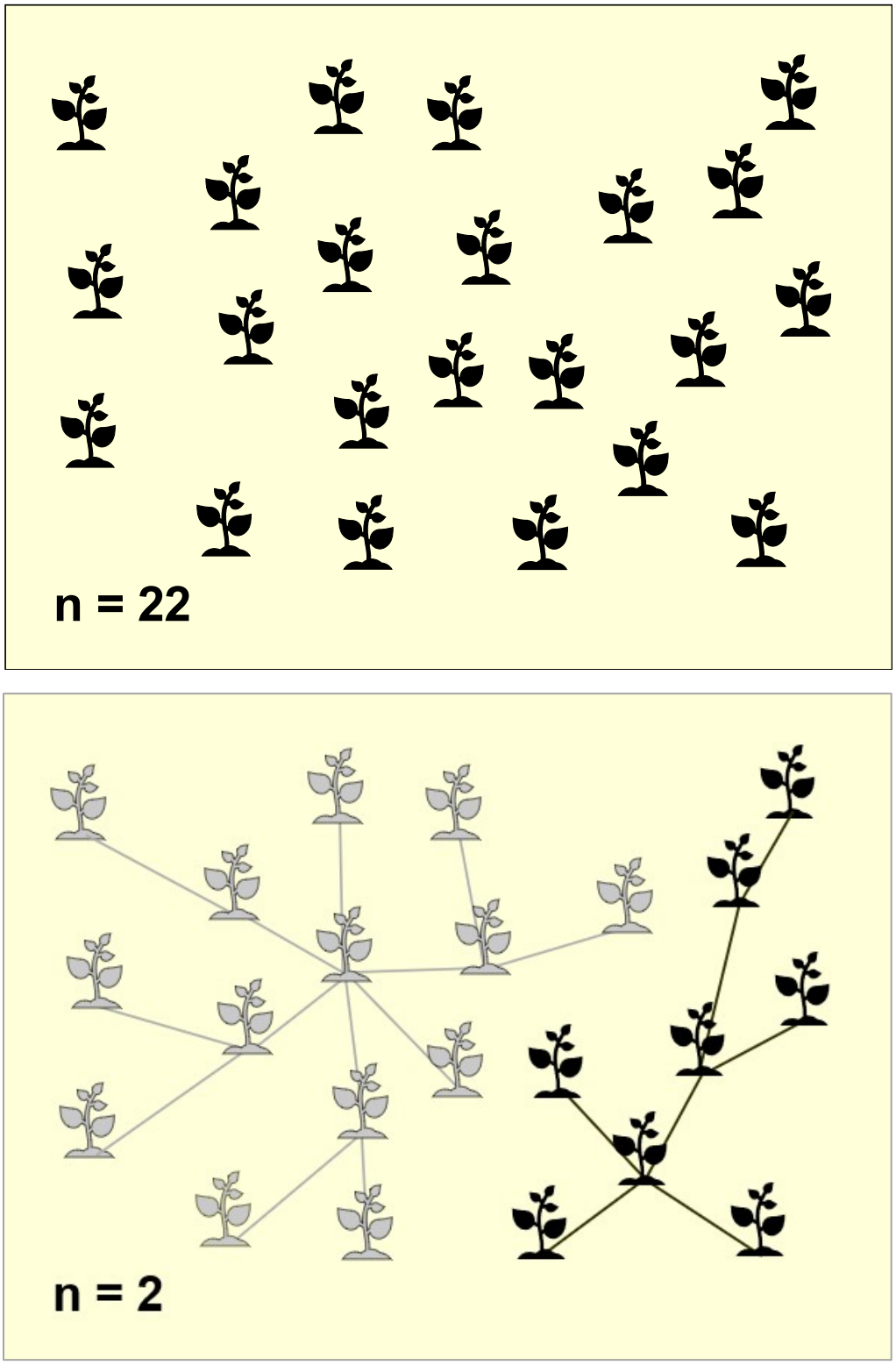


Figure 4. Relationship of Ramets to Genets. Top: Illustration of a population appearing as 22 individual plants (ramets). Bottom: Illustration showing there are only two genetically distinct individuals (genets), each made up of numerous clones.

wreath, which was shown to contain only one genotype per population sampled in a 1994 study (Freiley 1994).

Table 2. Number of Genets Compared to Ramets at Shasta Snow-wreath Populations Sampled in DeWoody et al. (2012).

CNDDB Occurrence #	Population Name	Estimated Population Size (Ramets) [+]	Genets
1	Cedar Creek	Not available (thousands?)	6
2	Squaw Creek	Not available	2
3	Ellery Creek/South of Ellery Creek (former EO #4)	1000s	4
5	Curl Creek	1729	4
6	Campbell Creek	1022	2
7	Low Pass	11,708	4
10	Cove Creek/South of Cove Creek	1000s	8
11	Ripgut Creek	100	2
12	Stein Creek	716 to "thousands"	15
14	Waters Gulch	20,100	2
15	Keluche Creek	500–1000	2
16	Blue Ridge West	4585	1
16	Blue Ridge Middle	20-30	1
16	Blue Ridge East	250-350	1
17	Flat Creek	1000s	3
18	Brock Creek	100+	3
19	Stein West	1000s	2
20	Shasta Caverns	<100	1
21	Jones Valley	3878	1
	TOTAL	**>48,808**	**48***

[+] Some CNDDB Occurrences document population estimates for multiple years, and some estimates are from partial surveys or a portion of the occurrence. The most recent and complete estimates were used in this table.

* The total number of genets is not a sum of all the genets reported from sampled subpopulations, since some genets were reported as occurring at multiple subpopulations. DeWoody et al. (2012) identified a total of 48 genets across all subpopulations.

Overall, DeWoody et al. (2012) revealed low levels of genetic diversity in Shasta snow-wreath. Lower levels of genetic variation are typically observed in rare and endemic species (species that occur in only one geographic location) than in closely related taxa with broader distributions (Gitzendanner and Soltis 2000; Cole 2003). The low levels of genotypic diversity of Shasta snow-wreath may be a consequence of the narrow range of the species, or it could be the result of historic population bottlenecks (DeWoody et al. 2012). The Shasta Lake area is known as a glacial and volcanic refuge in an ancient

geologic landscape, and the area supports many endemic species (Lindstrand and Nelson 2006). The low allelic variation of Shasta snow-wreath could be the result of range contraction during the last glacial period and subsequent climate variations (Lindstrand and Nelson 2006), or it could reflect a reduction in genetic diversity resulting from construction of Shasta Dam and the filling of Shasta Lake (DeWoody et al. 2012). Populations of Shasta snow-wreath were likely more connected prior to the construction of Shasta Dam, and Shasta Lake likely decreased the size of some populations and increased fragmentation of the populations, which can change the genetic structure of populations (Honnay and Jacquemyn 2007; Aguilar et al. 2008).

Similar-looking Plants

The vegetative structure of Shasta snow-wreath closely resembles the common shrubs ninebark (*Physocarpus capitatus*) and oceanspray (*Holodiscus discolor*), two other species in the rose family (see Figure 5) that grow in the same habitat as Shasta snow-wreath, and this similarity is likely a reason the species remained undiscovered by botanists for so long (Shevock et al. 1992; Taylor 1993).

Shasta snow-wreath looks very similar to its closest relative, Alabama snow-wreath. However, Alabama snow-wreath is restricted to the southeastern United States; thus, its range does not overlap with that of Shasta snow-wreath. The two species can be distinguished from each other based on the presence or absence of petals, number of stamens, and the length of sepals and styles (DeVore et al. 2005). Shasta snow-wreath flowers occasionally have petals, while Alabama snow-wreath flowers never have petals (Shevock et al. 1992; DeVore et al. 2005). The leaves are distinctive between the two species; Alabama snow-wreath leaves are longer with finer marginal teeth and Shasta snow-wreath leaves are shorter and wider, with coarser teeth (Shevock et al. 1992).

Habitat that may be Essential to the Continued Existence of the Species

Shasta snow-wreath primarily grows in riparian areas in the dense understory of shady montane hardwood-conifer and ponderosa pine forests, but is also found in foothill pine-blue oak woodland habitat (Shevock et al. 1992; Lindstrand and Nelson 2005b, 2006; Jules et al. 2017; CNDDB 2021). Shasta snow-wreath populations occur on limestone and a variety of substrates derived from metamorphic and igneous formations, such as shale, mudstone, and greenstone (Lindstrand and Nelson 2006; DeWoody et al. 2012; Jules et al. 2017; Soil Survey Staff 2019a,b). The Department's preliminary identification of the habitat that may be essential to the continued existence of Shasta snow-wreath includes: (1) habitats that fit the general habitat descriptions provided below, (2) habitats that are located at any of the 26 known Shasta snow-wreath populations, and (3) habitats located at any Shasta snow-wreath populations that are discovered or established in the future.

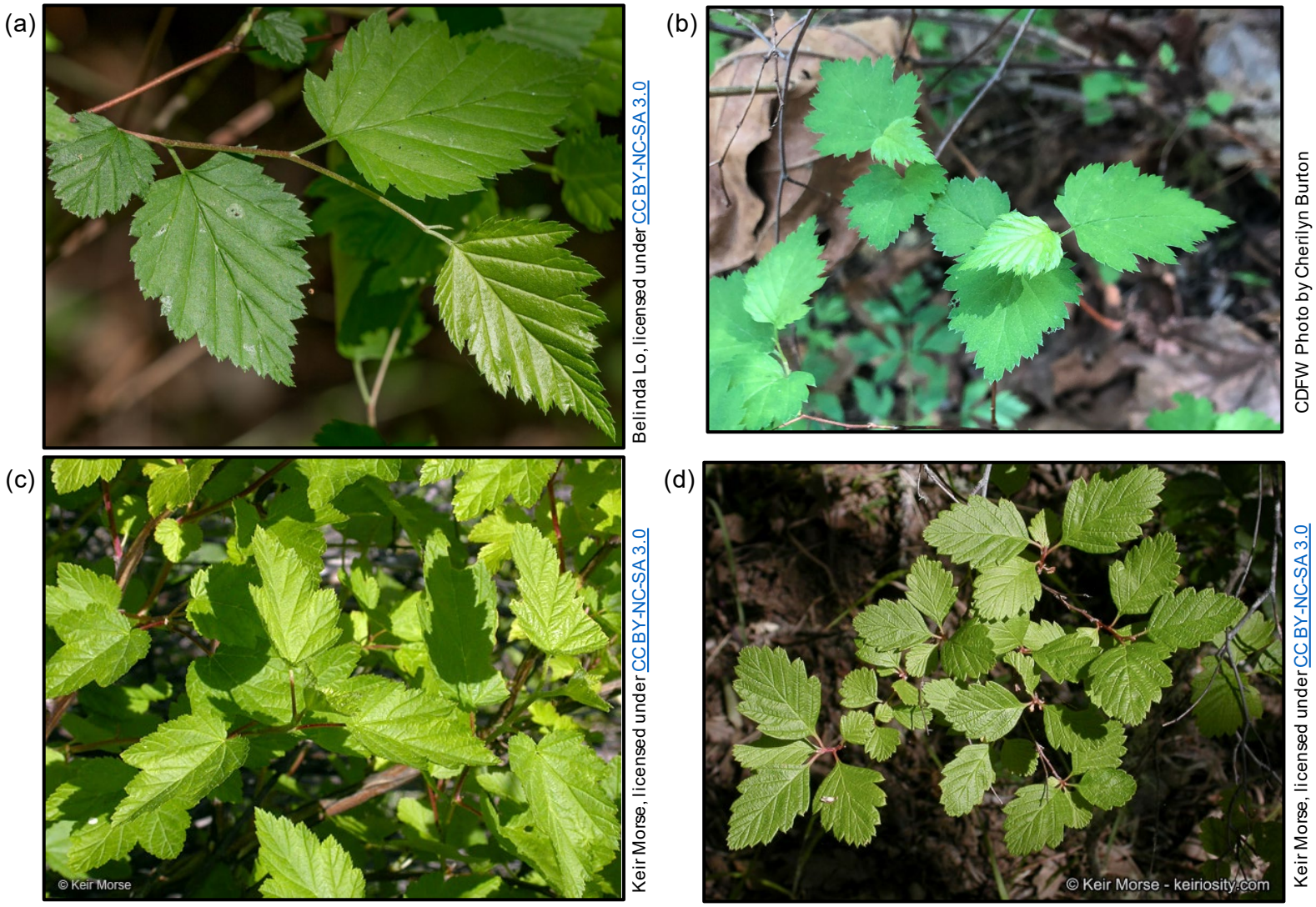


Figure 5. Shasta Snow-wreath and Similar Looking Species. (a) and (b) Shasta snow-wreath (*Neviusia cliftonii*). (c) Ninebark (*Physocarpus capitatus*). (d) Oceanspray (*Holodiscus discolor* var. *discolor*).

Vegetation Communities

The Department uses A Manual of California Vegetation (Sawyer et al. 2009; CNPS 2021) to classify natural communities within California. However, the area where Shasta snow-wreath occurs has not yet been classified using A Manual of California Vegetation, so specific vegetation alliances and associations at Shasta snow-wreath populations have not yet been delineated. While the habitat where Shasta snow-wreath occurs is not yet classified in A Manual of California Vegetation (Sawyer et al. 2009; CNPS 2021), the species composition at populations suggests that the vegetation communities would likely be placed in the *Pseudotsuga menziesii* Forest and Woodland Alliance (Douglas fir forest and woodland), *Pinus ponderosa* Forest and Woodland Alliance (ponderosa pine forest and woodland), *Quercus kelloggii* Forest and Woodland Alliance (California black oak forest and woodland) or the *Quercus douglasii* Forest and Woodland Alliance (blue oak woodland and forest) (CNPS 2021). Figure 6 shows Shasta snow-wreath habitat.

The dominant tree species that are associated with Shasta snow-wreath include California black oak (*Quercus kelloggii*), Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*), big-leaf maple (*Acer macrophyllum*), canyon live oak (*Quercus chrysolepis*), ponderosa pine (*Pinus ponderosa*), California bay (*Umbellularia californica*), Oregon oak (*Quercus garryana*), and foothill pine (*Pinus sabiniana*), and dominant understory species include western poison oak (*Toxicodendron diversilobum*), wild rose (*Rosa* spp.), snowdrop bush (*Styrax redivivus*), wild mock orange (*Philadelphus lewisii*), and mountain dogwood (*Cornus nuttallii*). Other species associated with Shasta snow-wreath include California hazel (*Corylus cornuta* subsp. *californica*), California buckeye (*Aesculus californica*), western redbud (*Cercis occidentalis*), elk clover (*Aralia californica*), pacific madrone (*Arbutus menziesii*), and snowberry (*Symphoricarpos albus* var. *laevigatus*) (Ertter 1993; Lindstrand and Nelson 2005a; Jules et al. 2017; CNDDB 2021). The invasive Himalayan blackberry (*Rubus armeniacus*) and Scotch broom (*Cytisus scoparius*) have been recorded at many of the Shasta snow-wreath populations (CNDDB 2020, Departmental observation).

Geology and Soils

Shasta snow-wreath is found in the Klamath Mountains Geomorphic Province, which has rugged topography with prominent peaks and ridges reaching up to approximately 2400 meters (8000 feet) above sea level (California Geological Survey 2002). The Klamath Mountains Geomorphic Province is mainly underlain by ancient (65 million to 542 million years old) sedimentary, volcanic, and metamorphic rocks containing numerous ultramafic bodies (igneous rocks with high levels of magnesium and iron and only a very small amount of silica), and gabbroic and granitic rock intrusions (Hotz 1971). The Shasta Lake area is known as an ancient landscape relative to surrounding

(a)

(b)

Figure 6. Shasta snow-wreath habitat. (a) Manzanita Hill, CNDDB element occurrence 22. (b) Ellery Creek, CNDDB element occurrence 3.

regions because it has been unaffected by glaciation and has not been overlain by volcanic material (Lindstrand and Nelson 2006).

Shasta snow-wreath was first discovered at the base of an exposed, north facing limestone outcrop (Shevock et al. 1992; Taylor 1993), and the first three Shasta snow-wreath populations were all found on limestone rock formations. The species was originally described as being restricted to limestone, but it is now known to occur on a variety of substrates derived from metamorphic and igneous formations, such as shale, mudstone, and greenstone (Lindstrand and Nelson 2006; DeWoody et al. 2012; Jules et al. 2017; Soil Survey Staff 2019a,b).

Climate, Hydrology, and other factors

Shasta snow-wreath occurs in western Shasta County, which experiences a Mediterranean climate with hot, dry summers and cool, wet winters. Winter temperatures at lower elevations are mostly above freezing, and summer temperatures are very high. Using 1943-2016 climate data from the nearest weather station at Shasta Dam, the average low/high during January, the coldest month, is 3.8º/11.4º C (38.9º/52.5º F), and the average low/high during July, the hottest month, is 20.2º/35.1º C (68.3º/95.2º F) (WRCC 2016). Areas at higher elevation receive 150 to 250 cm (60 to 100 in) of precipitation annually, but areas in the canyons receive only about half that of the mountain slopes (Sawyer 2006). About 90 percent of the precipitation falls between October and April, mostly as rain with very little snowpack. Only the highest nearby peaks hold snow into the summer. There are occasional summer thunderstorms which can release significant localized rain.

Shasta snow-wreath populations are found near Shasta Lake in the McCloud River, Cow Creek, Pit River, Sacramento River, and Squaw Creek watersheds (Lindstrand and Nelson 2006; CNDDB 2021). Populations are most often found in riparian zones, which are areas associated with rivers and streams that are transitional between terrestrial and aquatic ecosystems. Shasta snow-wreath potentially receives a portion of its water from the water table associated with riparian zones. However, plants growing outside of the flood plain likely receive the majority of their water from precipitation.

Shasta snow-wreath grows in an area that historically experienced frequent wildfires (Taylor and Skinner 2003; Fry and Stephens 2006; Safford and Van de Water 2014), with an average fire return interval of 12 years (Jules et al. 2017). The California black oak woodlands and Pacific ponderosa pine – Douglas-fir forests where Shasta snow-wreath populations occur exhibit very high departures from pre-Euro-American settlement fire frequencies (Safford and Van de Water 2014) and the presence of the relatively fire-intolerant Douglas-fir in the overstory is indicative of prolonged fire suppression in the region/area (Jules et al. 2017).

In the Klamath Mountains, thunderstorms occur in the dry summer months (Newburn and Payne 2014) and lightning ignitions peak in July and August (Schroeder and Buck 1970). The long summer drought that is typical of the Mediterranean climate results in dry conditions that make the region highly susceptible to wildfire by August or September (Taylor and Skinner 1998). Skinner et al. (2006) indicate that lightning-caused fires account for the majority of area burned in recent decades. Lightning may ignite hundreds of fires over a 24-hour period. The large number of potential simultaneous ignitions coupled with poor access for fire-suppression activities and the steep terrain of the Klamath Mountains has led to instances where lightning-ignited fires burned for weeks to months over very large areas (Skinner et al. 2006). Fire severity is highly variable in the Klamath Mountains, primarily due to climatic variables and diverse topography and vegetation assemblages (Taylor and Skinner 1998; Skinner et al. 2006). Typically, high-severity burns occur on the ridgetops and upper portions of slopes, especially on west- and south-facing aspects. Lower slopes and north- and east-facing aspects generally experience low-severity fires, and middle slope areas experience intermediate severity patterns (Skinner et al. 2006).

Little information is available on the response of Shasta snow-wreath to common disturbances such as fire. In a study conducted by Jules et al. (2017), the populations of Shasta snow-wreath in areas with a relatively low canopy cover of live trees had the greatest number of ramets and the tallest stems, which could suggest that removal of the canopy by fire may have been a beneficial disturbance for this species. Reducing canopy cover either by restoring a more frequent fire interval through prescribed burning or employing mechanical fuels treatment could benefit Shasta snow-wreath. Shasta snow-wreath was observed resprouting following a low-intensity prescribed burn in 2011 (Jules et al. 2017).

Although Shasta snow-wreath occurs in a historically fire-prone region, only one of the 26 known populations of Shasta snow-wreath experienced a wildfire since the species' discovery in 1992. The Hirz fire burned through the Ellery Creek/South of Ellery Creek population (CNDDB element occurrence 3) in 2018, with moderate to high intensity. Post-fire monitoring was initiated in 2018, and in 2019 Shasta snow-wreath was observed resprouting vigorously (Lindstrand et al. 2020). Fire has been documented to stimulate seed germination in many shrub species in fire prone areas, but no seedlings of Shasta snow-wreath were observed, further supporting that this species only reproduces vegetatively (Lindstrand et al. 2020). During site visits in 2020 and 2021, the burned population of Shasta snow-wreath was dense and portions of the population were observed flowering (Lindstrand et al. 2020; Departmental observation 2021).

ABUNDANCE AND POPULATION TRENDS

Shasta snow-wreath populations are reported as having population sizes ranging from 20 to approximately 20,000 (Jules et al. 2017; CNDDB 2021); however, these are estimates of the number of ramets (above ground stems) observed in each population, which represent clones of the same plant. DeWoody et al. (2012) identified a total of 48 genets (genetically distinct individuals) across 17 sampled populations, with the number of genets at each population ranging from 1-15. Genets are considered genetically unique individuals, and the number of genets may actually be more representative of the actual number of plants present in each population. If the number of genets is used as an indicator of the number of plants in Shasta snow-wreath populations, then the populations are considered quite small (potentially as few as 1-15 individuals at each population).

Shasta snow-wreath has only been known to science since 1992, and little formal monitoring or research has been conducted on the species in the past 29 years. As a result, scientific information on Shasta snow-wreath's population trends is limited. Jules et al. (2017) initiated monitoring of Shasta snow-wreath in 2011 at seven CNDDB occurrences, and population data was collected between 2011 and 2013. Two to three years of data was collected from each population, and no significant difference was found in "ramet population size" between years (Jules et al. 2017). During the study, permanent monitoring plots were established, which provide the opportunity for future monitoring at these populations, but no additional monitoring has been reported from these locations. Lindstrand et al. (2020) also conducted two years of qualitative monitoring at one population (Ellery Creek/South of Ellery Creek, CNDDB element occurrence 3) following the 2018 Hirz Fire. No other information on population monitoring activities is available.

Although long-term population monitoring has not been conducted for Shasta snow-wreath, the species likely experienced a significant reduction in distribution as a result of the construction of Shasta Dam in 1945 and the subsequent filling of Shasta Lake in 1948. It is very likely that populations of Shasta snow-wreath were connected by the riparian zones of the Sacramento, McCloud, and Pit rivers and their tributaries prior to the construction of Shasta Dam because many of the current Shasta snow-wreath populations reach their lower limit at the edge of Shasta Lake (Lindstrand and Nelson 2006; Jules et al. 2017). It is therefore likely that Shasta snow-wreath populations and habitat were eliminated by inundation from the rising waters of Shasta Lake following completion of Shasta Dam (DeWoody et al. 2012). At least six of the known populations were likely partially flooded by the creation of Shasta Lake (Lindstrand and Nelson 2006), but the extent of loss is unknown since this species and the extent of its distribution was not known when Shasta Lake was created in 1948.

FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE

Genetics, Reproductive Challenges, and Small Population Size

Shasta snow-wreath has been shown to have low genetic diversity across the species, as well as lower genetic diversity within populations than between populations (DeWoody et al. 2012). Population sizes of Shasta snow-wreath as estimated by the number of above ground stems in the populations are reported as ranging from 20 plants to thousands of plants. However, populations seemingly comprised of thousands of stems (ramets) could actually be comprised of just one or a handful of genetically unique individual plants (genets). The study conducted by DeWoody et al. (2012) of 21 subpopulations found that the number of genets per subpopulation sampled ranged from 1-15, with a mean of about 3 genets per subpopulation. Five of the sampled subpopulations consisted of only a single genet, indicating that all of the seemingly individual plants were simply clones that were genetically identical (DeWoody et al. 2012).

Low genetic diversity within populations is typically observed in rare and endemic species (Gitzendanner and Soltis 2000; Cole 2003; DeWoody et al. 2012) and is consistent with the almost exclusively asexual, vegetative reproduction of Shasta snow-wreath (DeWoody et al. 2012). In addition, species that reproduce vegetatively have greater potential for their populations to be genetically isolated and distinct, as observed with Shasta snow-wreath populations, since vegetatively reproducing species have poor long-distance dispersal capability via pollen or seed (Ellstrand and Roose 1987; Hamrick and Godt 1996; Silvertown 2008).

Genetic diversity is an important factor in the viability of clonal species. Populations with high genetic diversity have a greater capacity to adapt to changing conditions, such as from climate change, thus increasing their ability to persist. Low genetic diversity, as observed in Shasta snow-wreath populations, reduces adaptive capacity to climatic changes or other disturbances, potentially leading to reduced survival (Lande and Shannon 1996; Hughes et al. 2008; de Witte and Stöcklin 2010; Hoffmann and Sgro 2011).

Although Shasta snow-wreath plants produce seeds, no seedlings of this species have been observed (Lindstrand et al. 2020) and efforts to germinate seeds have been unsuccessful (Ertter and Shevock 1993), suggesting that Shasta snow-wreath may be incapable of reproducing by seed under current environmental conditions. Although the current role of sexual reproduction appears to be low, populations of some potential pollinators, including numerous species of bumblebees, are rapidly declining (Hatfield et al. 2012). The apparent inability to reproduce by seed limits the dispersal capability of Shasta snow-wreath, which is confounded by the steep terrain and topography of its

habitat and by human introduced impediments, such as roads, campgrounds, and Shasta Lake. Lack of sexual reproduction makes adaptation to changing conditions very challenging, since sexual reproduction promotes genetically diverse offspring through recombination, mutation, and gene flow from immigrants (Yang and Kim 2016). In addition, genetic diversity is likely to increase the adaptability of populations to adverse environmental conditions, diseases, and other disturbances (Yang and Kim 2016). Evolutionary adaptation may be the only way that populations of rare species with limited dispersal capability can persist in the face of climate change (Hoffmann and Sgro 2011). Given that Shasta snow-wreath populations have limited dispersal capability and are unlikely to expand into nearby suitable habitat due to topographic limitations of the area, their low genetic diversity and resulting low adaptive capacity makes the populations vulnerable to extirpation due to a changing climate.

DeWoody et al. (2012) found that Shasta snow-wreath populations exhibit low genetic diversity, and that populations may be comprised of only one or very few genetically distinct individual plants (genets). A genet is the distinct individual that develops from a fertilized seed, and ramets are replicates and essentially unchanged descendants of the genet (Silvertown 2008; Tepedino 2012). Although seemingly comprised of many individuals (ramets), Shasta snow-wreath populations are actually small when considering the number of genets or actual individuals in each population. Species with small population sizes are highly vulnerable to extinction due to stochastic (chance) demographic, environmental, and genetic events (Shaffer 1981; Dirzo and Raven 2003). Chance events such as a landslide or drought could result in the loss of all or a significant portion of a Shasta snow-wreath population.

Extinction debt refers to the future extinction of a species due to past disturbances. It can take a considerable amount of time for a population or species to diminish and disappear following disturbances such as habitat loss or degradation (Kuussaari et al. 2009). The probability and magnitude of extinction debt depends on several factors, such as the life history traits of a species, the spatiotemporal configuration of habitat patches, and the time since and nature of the alteration of the habitat. Empirical evidence suggests that delayed extinctions are more likely in species with low turnover rates, such as in perennial plants versus annual plants. In addition, microhabitat specificity and the probability of dispersal of the species can also contribute to the probability of extinction debt (Kuussaari et al. 2009). The lack of genetic diversity in Shasta snow-wreath populations as assessed in the DeWoody et al. study may indicate that Shasta snow-wreath is a relict species that is not well adapted to its current refugia or that Shasta snow-wreath is a narrowly distributed species that is highly adapted to its habitat (Lindstrand and Nelson 2006; DeWoody et al. 2012). Geological events (e.g. glacial and/or volcanic activity) in surrounding regions may have led to the permanent isolation of Shasta snow-wreath to an area where it could persist for a long time as a

relict species (Lindstrand and Nelson 2006), delaying its extinction (Jablonski 2002). Additional fragmentation of Shasta snow-wreath occupied habitat from the creation of Shasta Lake could also contribute to this potential risk of extinction, albeit delayed. The perennial, long-lived nature of Shasta snow-wreath, together with its isolated populations and low dispersal capabilities, creates a scenario where extinction debt is a possible phenomenon for this species. If Shasta snow-wreath is experiencing extinction debt, human-induced threats only accelerate the pace towards extinction, though humans may also be able to intervene to slow the time to extinction.

Habitat Modification and Destruction

Habitat loss at local, regional, and global scales is considered the primary cause for species extinctions worldwide (Wilcove et al. 1998; Randall and Hoshovsky 2000; Dirzo and Raven 2003; Rybicki and Hanski 2013).

The federal Bureau of Reclamation is proposing to raise the height of Shasta Dam to increase water storage capacity of the Shasta Lake reservoir, and the Shasta Lake Water Resources Investigation (SLWRI) Final Environmental Impact Statement (EIS) was completed for the project in 2015 (USDI BOR 2015). The SLWRI Final Supplemental EIS was released on November 19, 2020. Shasta Lake currently stores approximately 561,000 hectare-meters (4.55 million acre-feet) of water and the maximum surface area of the lake covers an area of about 11,940 ha (29,700 ac). The preferred alternative would raise the dam by 5.6 m (18.5 ft), and would increase the height of the reservoir full pool by 6.3 m (20.5 ft) (USDI BOR 2015). This vertical increase of 6.3 m (18.5 ft) will significantly increase the area of the reservoir and translates to the inundation of approximately 13,071 ha (32,300 ac) of land surrounding Shasta Lake that is presently not underwater and supports populations of Shasta snow-wreath or could be potential habitat (USDI BOR 2015). The current maximum water surface elevation is 328 m (1076.2 ft) (USDI BOR 2021).

If implemented, raising the height of Shasta Dam would directly impact 50 percent (13 of 26) of the known Shasta snow-wreath populations. Table 3, below, lists the area of direct impacts (inundation) to each population, which is based on the area that each Shasta snow-wreath population occupies.

Information on areal extent and impacts was not available for all populations because four populations that will be impacted by the rising water level were discovered after the SLWRI EIS was completed and after the impact analysis was conducted. However, the lower elevational extent of these four populations occurs at the current high-water mark or immediately adjacent to the current high-water mark of Shasta Lake, and thus the project to raise the height of Shasta Dam

Table 3. Direct Impacts to Shasta Snow-wreath Populations from the Proposed Project to Raise Shasta Dam

CNDDB Element Occurrence #	Population Name	Population Total Area (acres)	Area of Population Inundated (acres) +	Percent of Population Inundated
3	Ellery Creek/South of Ellery Creek	41.85*	0.047	<1%
6	Campbell Creek	1.9*	0.04	2%
10	Cove Creek/South of Cove Creek	1.33	0.55	41%
12	Stein Creek	42.15+	0.469	1%
15	Keluche Creek	0.15*	0.146	97%
16	Blue Ridge	1.17*	0.752	64%
18	Brock Creek	1.38*	0.634	46%
20	Shasta Caverns	0.08*+	0.018	23%
21	Jones Valley	0.34*	0.015	4%
	Total	90.35	2.67	3%
24	East of Stein Creek	Not available	Not available	Not available
25	North of Marble Creek	1.37*	Not available	Not available
27	Bear Canyon	Not Available	Not Available	Not Available
28	Roberts Canyon	Not available	Not Available	Not Available

*Source: Detailed digital mapping data submitted to the CNDDB in shapefile format.
+ Source: SLWRI Final EIS (2015)

will inundate at least some proportion of each of these populations (Lindstrand pers. comm. 2020). The level of impact to Shasta snow-wreath populations resulting from the proposed project to raise Shasta Dam varies for each population, with the lowest proportion of impact at less than one percent (Table 3; Ellery Creek/South of Ellery Creek Population, CNDDB element occurrence 3). The largest proportional impact to a population is 97 percent (Table 3; Keluche Creek, CNDDB occurrence 15). This is a relatively small population (0.06 ha [0.15 acre]) and represents a small portion of the total area of all Shasta snow-wreath populations combined. Nevertheless, the population will be nearly eliminated if the Shasta Dam raise project is implemented, losing important genetic diversity of the species along with it. At least five populations will have impacts to more than 20 percent of their occupied area. The areal extent is not available for all populations of Shasta snow-wreath, and some estimates of area are less precise than others. When considering 9 of 26 populations of Shasta snow-wreath with available population information, the proposed project to raise Shasta Dam, if implemented, would result in a loss of three percent of the total area of these nine populations. This equates to an approximately one percent loss of the species. However, the project would impact half of the known populations to some extent. The

area estimates do not include potential impacts at the four populations that are not discussed in the SLWRI EIS (CNDDB element occurrences 24, 25, 27, and 28) because that information is not available, so it is possible that the proportion of impact could be greater when considering those impacts.

Shasta Lake experiences a high level of recreational use including boating, fishing, and camping. Shasta Lake is also popular for houseboat rentals. Raising the height of Shasta Dam could lead to additional direct impacts and indirect impacts to Shasta snow-wreath and its habitat by increasing the amount of human activity at the newly created shoreline from campers, boaters, and other visitors to the area. An increase in human activity would cause disturbance of the area and could result in an increase in soil compaction, impacts to vegetation, and an increase in garbage and pollution. Increased disturbance also could lead to a degradation of habitat, creating conditions favorable to the spread of invasive species.

Six populations of Shasta snow-wreath are located partially or entirely on privately owned lands. Of these, four populations are at least partially on lands owned by Sierra Pacific Industries (SPI), a forest products company (CNDDB 2021; Digital Map Products 2021). Timber harvest is subject to the Z'berg-Nejedly Forest Practice Act of 1973 (Pub. Resources Code, § 4511 et seq.) and the California Forest Practice Rules which are administrated by the California Department of Forestry and Fire Protection (CAL FIRE). The Forest Practice Act was enacted to ensure that logging is done in a manner that will preserve and protect our fish, wildlife, forests, and streams (CAL FIRE 2021). However, special status plants, particularly those not listed as rare, threatened, or endangered under federal or state law are given less consideration under the Forest Practice Act.

Timber harvest occurred within two of the four Shasta snow-wreath populations between 2012 and 2015 (CNDDB element occurrences 12 and 23). At CNDDB element occurrence 12 (Stein Creek), timber harvest activities also included the construction of new access roads and crossings that resulted in impacts to Shasta snow-wreath plants and created disturbance in the area, increasing the potential for introducing and spreading non-native species. During timber harvest activities, a portion of CNDDB element occurrence 12 was protected in an SPI Habitat Retention Area (HRA). Selection harvesting of single trees took place at CNDDB element occurrence 23 (McCandless Gulch), and harvesting activities provided an opportunity to monitor the response of Shasta snow-wreath to timber harvesting activities. SPI established six permanent transects (five treatment and one control) at CNDDB element occurrence 23 in September 2014 in association with Timber Harvest Plan (THP) 2-13-059-SHA (McChicken THP). The treatment transects are in a selection harvest area, and two of these are in an area where herbicide was inadvertently applied while targeting Himalayan blackberry. The transects were reread in August 2014, and an additional

control transect was established. The monitoring methodology was similar to Jules et al. (2017). Initial observations suggested the herbicide was effective at killing Shasta snow-wreath, but follow-up monitoring for response to tree canopy reduction has not yet been conducted. In addition to tree removal and the inadvertent herbicide application, timber operations included creation of tractor skid trails and a small temporary landing where trees were skidded to for loading on trucks.

Timber harvest occurred near the third SPI-owned population during 2014 to 2015 (Manzanita Hill, CNDDB element occurrence 22), but the Shasta snow-wreath population was avoided and protected in an SPI HRA and a Watercourse and Lake Protection Zone (Lindstrand pers. comm. 2020) (§ 916 et seq., Title 14, CCR), which is a defined area along a stream where the Forest Practice Rules limit the amount of timber harvested in order to protect in-stream habitat quality for fish and other resources. No timber harvest has been reported at the fourth population (Bear Gulch, CNDDB element occurrence 8) located on SPI property (CNDDB 2021). Any future timber harvest in Shasta snow-wreath populations could pose a potential threat to this species.

A portion of one Shasta snow-wreath population that is located on SPI property is also on private property owned by Stimple-Wiebelhaus Associates (Bear Gulch, CNDDB element occurrence 8), a construction and excavation company. No excavation is presently occurring on the property, but the plants are currently unprotected. One Shasta snow-wreath population (CNDDB element occurrence 9) occurs at the Mountain Gate Quarry, which is also part of the Stimpel-Wiebelhaus Associates family of companies. The population is not within the current mining area, but mine expansion could impact Shasta snow-wreath. The other population of Shasta snow-wreath that is located partially on privately-owned property (Squaw Creek, CNDDB element occurrence 2) is owned by a private citizen and the site is currently unmanaged (CNDDB 2021; Digital Map Products 2021).

One Shasta snow-wreath population (Waters Gulch, CNDDB element occurrence 14) is bisected by the Waters Gulch Trail, which was developed prior to the discovery of Shasta snow-wreath. The trail is subject to impacts from trail maintenance; however, these impacts appear to be minimal and consist of pruning and cutting branches that encroach onto the trail. Cut stems along the trail were observed resprouting during a site visit conducted by CDFW staff in April 2021 (Departmental observation) (see Figure 7). Another population (Low Pass, CNDDB element occurrence 7) grows along both sides of a historic jeep trail in the Devils Rock-Hosselkus Research Natural Area established by the U.S. Forest Service (USFS ALP 2015b; CNDDB 2021), which is managed to maintain its natural features and to maintain natural processes (USDA 2014). Currently this jeep trail functions as a foot path (Lindstrand pers. comm. 2020). No information was found regarding maintenance of the jeep trail/foot path.

(a)

(b)

Figure 7. Shasta Snow-wreath Population at Waters Gulch (CNDDB Element Occurrence 14). (a) The Waters Gulch Trail that cuts through part of the Waters Gulch Shasta snow-wreath population at CNDDB EO 14; (b) Shasta snow-wreath resprouting from cut stems along the edge of the trail.

Invasive Species

Studies have not been conducted on the impact of invasive species on Shasta snow-wreath specifically; however, the negative impacts of plant invasions on Mediterranean ecosystems have been well documented (Gaertner et al. 2009; Fried et al. 2014). Invading alien species cause major environmental damages and losses and are a significant risk factor leading to the extinction of threatened and endangered species (Wilcove et al. 1998; Pimentel et al. 2004; Conser and Connor 2009). Invasive non-native plants present a complex threat to biodiversity that is difficult to manage and has long-lasting effects. North America has accumulated the largest number of naturalized plants in the world (van Kleunen et al. 2015), which are non-native plants that reproduce in the absence of human benefit and persist beyond initial colonization. Many non-native plant species have become established within California, dramatically changing the state's ecological landscape (Conser and Connor 2009). Many studies hypothesize or conclude that competition is the factor responsible for the observed negative impacts of invasive species on biodiversity (D'Antonio and Vitousek 1992; Wilcove et al. 1998); however, invasive species may also impact native ecosystems by altering environmental conditions and resource availability (D'Antonio and Vitousek 1992; Levine et al. 2003). Invasive species may threaten native populations through competition for light, water, or nutrients; allelopathic mechanisms; alteration of soil chemistry; thatch accumulation that inhibits seed germination and seedling recruitment; changes in natural fire frequency; disruptions to pollination or seed-dispersal mutualisms; changes in soil microorganisms; or other mechanisms (Levine et al. 2003). The magnitude of detrimental effects of invasive species in a Mediterranean climate, as is found in California, largely depends on characteristics of the invading species and the habitat being invaded (Fried et al. 2014). The invader's vegetative structure and ability to form dense patches influence the magnitude of impacts (Gaertner et al. 2009; Fried et al. 2014). Invasive species may also influence native species colonization rates and may thus lead to declines in local diversity over longer timescales (Yurkonis and Meiners 2004).

Invasive plant species, including Himalayan blackberry and Scotch broom, have been documented at twelve of the Shasta snow-wreath populations (Lindstrand pers. comm. 2020, CNDDB 2021, Departmental observation). It is likely that these or other invasive plant species occur within other Shasta snow-wreath populations but have not been reported, especially Himalayan blackberry, which commonly grows in similar habitat as Shasta snow-wreath. Himalayan blackberry forms dense, impenetrable thickets, particularly along watercourses (see Figure 8, below). Himalayan blackberry is highly competitive with other plants, and thickets produce such a dense canopy that other plants cannot germinate beneath them due to lack of light (Hoshovsky 2000). Scotch broom is a long-lived strongly competitive perennial shrub that grows in sunny sites,

spreading rapidly through forest borders and along roadsides. Scotch broom can crowd out native species and has a seedbank that can remain viable for up to 30 years, making invasions difficult to control. Scotch broom also burns readily and carries fire into the tree canopy, increasing fire intensity (Bossard 2000).

Figure 8. Invasive Species. Himalayan blackberry invasion seen in the foreground at the Manzanita Hill Shasta Snow-wreath Population (CNDDB element occurrence 22).

Climate Change

Warming of the climate system is well-documented in climate science data, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The ocean and the atmosphere have warmed, sea level has risen, and the amounts of snow and ice have declined (IPCC 2014). Evidence indicates that anthropogenic climate change has already had widespread impacts on natural systems globally and the effects are growing (Parmesan and Yohe 2003; Parmesan 2006; IPCC 2014). Climate change poses a serious threat to California's ecosystems and will alter the fundamental character, production, and distribution of California's ecosystems during the current century (Knowles and Cyan 2002; Snyder et al. 2002; Snyder and Sloan 2005; Shaw et al. 2011). Climate change presents a major challenge to the conservation of California's natural resources, and it will intensify existing threats and create new threats to natural systems.

The climate in California is expected to be considerably warmer by the end of the century, resulting in more precipitation falling as rain instead of snow and a reduced

snowpack. In addition, the snowpack will melt much earlier in the year, and the higher snowlines will likely increase the frequency of flooding due to more frequent occasions of large-scale rainfall runoff (Kim et al. 2002; Miller et al. 2003; Hayhoe et al. 2004; Dettinger 2011; Dettinger et al. 2009). The decreased snowpack in the winter months will lead to a deficit of runoff in the late spring and summer, reducing total water availability (Snyder et al. 2002; Snyder and Sloan 2005).

Department staff assessed the vulnerability of Shasta snow-wreath to climate change using the NatureServe Climate Change Vulnerability Index Version 3.02 (NatureServe 2016). Based upon the Department's assessment, Shasta snow-wreath has a climate change vulnerability index value of Moderately Vulnerable (MV), indicating that available evidence suggests that abundance and/or range extent within the geographical area of the species is likely to decrease by the year 2050. However, some ecological and life history information used for the climate change vulnerability assessment is not yet known for Shasta snow-wreath. In particular, the Department does not know if Shasta snow-wreath can reproduce by seed or what the limiting factors are for seed germination, although it is presumed that reproduction by seed is absent or exceedingly rare. Furthermore, the Department does not know whether, or to what extent, competing plant species such as Himalayan blackberry and Scotch broom will be favored by projected future climates. Despite the lack of information about some of the ecological and life history information for Shasta snow-wreath, the confidence in the vulnerability index score is very high based on the results of the Monte Carlo simulation used in the index (Young et al. 2015).

Altered Fire Regimes

Following the fire suppression efforts of the past century, recent research has indicated that fire size and frequency are now increasing in western U.S. forests (Miller et al. 2012). Miller et al. (2012) noted the mean fire size, maximum fire size, and total area burned all increased over the period from 1910 to 2008 in northwestern California forests. They also reported the tendency of high severity fires to occur in years when region-wide lighting storms caused multiple ignitions, indicating that weather conditions in some years can favor widespread high intensity fires in northwestern California (Miller et al. 2012). The extent of the recent high-severity burns appears to be different than historic burning patterns, with more area burning at high intensity, and this is related, in part, to higher quantities and more homogeneous fuels caused by accumulation due to fire-suppression (Skinner et al. 2006). Miller et al. (2012) suggest the pattern of recent high-severity fires could be the result of the changing climate plus increasing and more fire-prone fuel loads in some forest types, potentially driven by a combination of human-related factors such as fire suppression and climate-driven factors such as drier fire seasons.

Disturbances, such as fire, shape forest ecosystems by influencing their composition, structure, and functional processes (Dale et al. 2001). Expanded areas of high-severity fire can impact tree regeneration, soil erosion, and water quality, which can greatly alter forest biodiversity and composition (CDFW 2021). Major shifts in fire regime and fire suppression have had profound effects on vegetation structure and composition of plant communities, threatening at-risk species and habitat (Shaffer 2006). High-severity fire can affect the ability of an ecosystem to recover, create favorable conditions for the expansion of non-native invasive plant species, and lead to the long-term or permanent loss of habitat (CDFW 2021). Although Shasta snow-wreath was observed vigorously resprouting following a single fire event (the 2018 Hirz fire), the long-term effects on Shasta snow-wreath populations due to potential changes in the forest and woodland communities resulting from altered fire regimes is unknown, but changing community structure could affect the ability of Shasta snow-wreath to persist.

REGULATORY AND LISTING STATUS

Federal

Shasta snow-wreath is not currently listed under the federal Endangered Species Act (ESA); however, a petition to list Shasta snow-wreath as endangered under the ESA was received by the U.S. Fish and Wildlife Service on October 3, 2019. On March 24, 2021, the U.S. Fish and Wildlife Service found that the petition presented substantial scientific or commercial information indicating that listing Shasta snow-wreath may be warranted, and announced plans to initiate a review of Shasta snow-wreath to determine if listing is warranted (USFWS 2021). Shasta snow-wreath is currently under review by the U.S. Fish and Wildlife Service.

Shasta snow-wreath is designated as a U.S. Forest Service Sensitive Species by the Shasta-Trinity National Forest. Forest Service Sensitive Species are plant and animal species for which population viability is a concern as evidenced by a downward trend in populations or in habitat capability to support the species (USDA 2005). The goal of sensitive species designation is to develop and implement management practices so these species do not become threatened or endangered and to prevent trends toward endangerment that would result in a federal listing. Management decisions by Shasta-Trinity National Forest are not to result in a trend towards federal listing or loss of viability of Shasta snow-wreath (USDA 2005).

State

On May 1, 2020, the Commission published its Notice of Findings for Shasta snow-wreath in the California Regulatory Notice Register, designating this species as a

candidate pursuant to CESA. The provisions of CESA apply to Shasta snow-wreath while it is a candidate species (Fish & G. Code, § 2085). CESA prohibits the import, export, take, possession, purchase, or sale of Shasta snow-wreath or any part or product of thereof, except in limited circumstances, such as through a permit or agreement issued by the Department under the authority of the Fish and Game Code. For example, the Department may issue permits that allow the incidental take of listed and candidate species if the take is minimized and fully mitigated, the activity will not jeopardize the continued existence of the species, and other conditions are met (Fish & G. Code, § 2081 subd. (b)). The Department may also authorize the take and possession of Shasta snow-wreath for scientific, educational, or management purposes (Fish & G. Code, § 2081 subd. (a)).

Section 15380(b) of the California Environmental Quality Act (CEQA) Guidelines state that a species is "rare" when it exists in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens. Because of the small number of populations and the threats facing Shasta snow-wreath, the species meets these criteria under CEQA. Any state, local, and other (non-federal) governmental actions with potential to affect the environment would be subject to review under CEQA and would be required to consider and disclose impacts to this species.

Natural Heritage Program Ranking

Natural heritage programs provide location, natural history, and rarity status information on special status plants, animals, and natural communities to the public, government agencies, and conservation organizations. There are more than 80 natural heritage programs throughout the western hemisphere that make up a network of similar programs overseen by NatureServe (CNDDB 2020). California's natural heritage program is the CNDDB. All natural heritage programs use the same ranking methodology originally developed by The Nature Conservancy and now maintained by NatureServe (NatureServe 2012). This ranking methodology consists of a global conservation status rank describing the status of a given taxon over its entire distribution, and a subnational (i.e., state) conservation status rank describing the status of the taxon over its state distribution (NatureServe 2021). Both global and subnational ranks reflect a combination of rarity, threat, and trend factors. Shasta snow-wreath has been assigned a global rank of G2 and a subnational rank of S2 (CNDDB 2021), indicating that the species is imperiled both within California and throughout its entire range, with a high risk of extinction due to a very restricted range, very few populations, steep declines, or other factors making it vulnerable to extirpation.

California Rare Plant Rank

Some plants in California are assigned a California Rare Plant Rank (CRPR) to identify them as species of conservation concern and to aid in analyses of projects for CEQA purposes. The Department works in collaboration with The California Native Plant Society (CNPS) and botanical experts throughout the state to assign rare and endangered plants a CRPR reflective of their status. Shasta snow-wreath has been assigned a CRPR of 1B.2 (CNDDB 2021). Plants with a CRPR of 1B are rare throughout their range with the majority of them endemic to California. Most of the plants that are ranked 1B have declined significantly over the last century. The threat code extension of "2" indicates that the species is moderately threatened in California, with 20 to 80 percent of occurrences threatened or a moderate degree and immediacy of threat (CNPS 2020).

EXISTING MANAGEMENT EFFORTS

There are currently no range-wide management efforts for Shasta snow-wreath.

National Forest Service Lands

Nineteen of the twenty-six populations of Shasta snow-wreath are located entirely on U.S. Forest Service lands, and two populations are partially on U.S. Forest Service lands on the Shasta-Trinity National Forest. The U.S. Forest Service manages their forests with a focus on managing vegetation, restoring ecosystems, reducing hazards, and maintaining forest health (USFS 2021a). U.S. Forest Service forest managers use timber sales, as well as other vegetation management techniques such as prescribed fire, to achieve these objectives (USFS 2021b). Land and Resource Management Plans (LMRPs) are prepared to guide management of individual national forests. The LRMP for the Shasta-Trinity National Forest (USDA 1995) identifies Shasta snow-wreath as a sensitive and endemic plant on the forest but does not include specific provisions to protect the species. The LRMP indicates that Species Management Guides have been developed and are being implemented for plant species of interest, such as Shasta snow-wreath, but no further information could be found on the Species Management Guide for this species. Since Shasta snow-wreath is designated as a U.S. Forest Service Sensitive Species, management decisions by Shasta-Trinity National Forest are not to result in a trend towards federal listing or loss of viability of the species or its habitat (USDA 2005). U.S. Forest Service policies for designated sensitive species include reviewing and disclosing impacts of federal activities on these species as part of the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. § 4321, et seq.) process and analyzing the significance of any impacts to these species or their habitat.

However, the NEPA review process does not include a requirement to minimize or mitigate impacts to the species.

One population of Shasta snow-wreath is located within the Devils Rock-Hosselkus Research Natural Area established by the U.S. Forest Service (USFS ALP 2015b; CNDDB 2021). Research Natural Areas include a network of federally-administered public lands that are managed with the purpose of maintaining the natural features for which they were established and to maintain natural processes. Non-manipulative research and monitoring activities are encouraged in Research Natural Areas (USDA 2014). Another population of Shasta snow-wreath is located partially within the Devils Rock-Hosselkus Research Natural Area and partially in an area of the Shasta-Trinity National Forest with no special designation (USFS ALP 2015b). Sixteen Shasta snow-wreath populations are located entirely within the Whiskeytown-Shasta-Trinity National Recreation Area (USFS ALP 2015a). The primary purposes of the National Recreation Area are for public outdoor recreation benefits and the conservation of scenic, scientific, historic, and other values which contribute to public enjoyment of the recreation resources (USDA 2014). Another Shasta snow-wreath population is located partially within the Whiskeytown-Shasta-Trinity National Recreation Area and partially within an area of the Shasta-Trinity National Forest with no special designation (USFS ALP 2015a).

Monitoring

Shasta snow-wreath has only been known to science since 1992, and little formal monitoring or research has been conducted on the species in the past 29 years. Jules et al. (2017) initiated monitoring of Shasta snow-wreath 2011 at seven CNDDB occurrences, and population data was collected between 2011 and 2013. During the study, permanent monitoring plots were established, which provide the opportunity for future monitoring at these populations, but no additional monitoring has been reported at these locations. Lindstrand et al. (2020) also conducted two years of qualitative monitoring at one population (Ellery Creek/South of Ellery Creek, CNDDB element occurrence 3) following the 2018 Hirz Fire. In addition, SPI initiated monitoring in 2014 in an area to be harvested at CNDDB element occurrence 23 (McCandless Gulch) using monitoring methods similar to Jules et al. (2017). Seven permanent monitoring plots were established in this population. No other information on population monitoring activities was available.

SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF SHASTA SNOW-WREATH IN CALIFORNIA

CESA directs the Department to prepare this report regarding the status of Shasta snow-wreath based upon the best scientific information available to the Department

(Fish & G. Code, § 2074.6). CESA's implementing regulations identify key factors that are relevant to the Department's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: 1. present or threatened modification or destruction of its habitat; 2. overexploitation; 3. predation; 4. competition; 5. disease; or 6. other natural occurrences or human-related activities" (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and Game Code provide key guidance to the Department's scientific analysis. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]" (*Id.*, § 2067).

The preceding sections of this Status Review report describe the best scientific information available to the Department, with respect to the key factors identified in the California Code of Regulations. The section below considers the significance of any threat to the continued existence of Shasta snow-wreath for each of the factors.

Present or Threatened Modification or Destruction of Habitat

Shasta snow-wreath populations are threatened by impacts from the potential project to raise the height of Shasta Dam. It is likely that Shasta snow-wreath populations were more widespread and have already been eliminated or reduced by construction of Shasta Dam and the filling of Shasta Lake in the 1940s. Although impacts to populations are considered small in relationship to total area of occupied habitat, 13 of the 26 (50 percent) known populations will be impacted to some extent if the project to raise Shasta Dam is approved. One population will be almost completely eliminated, which is significant since only 26 populations are known to exist. In addition to direct inundation from the rising waters, there could be indirect impacts from increased human use at the new lake shore, as well as unforeseeable effects that extend further into the population from altered hydrology and microhabitat conditions.

Although current impacts by timber harvest activities are relatively minor, some practices in Shasta snow-wreath occupied habitat have potential to impact this species, including road construction, changes in tree canopy, and creation of conditions favorable to the introduction and establishment of non-native species through soil

disturbance and heavy equipment operations. Additionally, expansion of the operation area of the Mountain Gate quarry could impact the population at this location.

The Department considers modification and destruction of habitat to be a significant threat to the continued existence of Shasta snow-wreath.

Overexploitation

Cuttings of Shasta snow-wreath have been collected by botanists and gardeners for propagation and cultivation in home gardens. Shasta snow-wreath is also available for purchase in some nurseries (Calscape 2021). However, collection activities do not appear to be extensive and do not appear to be threatening populations of Shasta snow-wreath. The Department does not consider overexploitation to be a significant threat to the continued existence of Shasta snow-wreath.

Predation

Although it is likely that some herbivory occurs on Shasta snow-wreath, the Department could not find any evidence that herbivory or predation is a threat to the species. The Department does not consider predation to be a significant threat to the continued existence of Shasta snow-wreath.

Competition

Invasive plant species have been documented to pose serious threats to biodiversity around the world and are a particularly pervasive problem in Mediterranean-type habitats like those in California. Himalayan blackberry, Scotch broom, and other invasive plants occur within and adjacent to Shasta snow-wreath populations. The Department considers competition with invasive plant species, particularly Himalayan blackberry and Scotch broom, to be a significant threat to the continued existence of Shasta snow-wreath.

Disease

There are no diseases known to be threats to the continued existence of Shasta snow-wreath. The Department does not consider disease to be a significant threat to the continued existence of Shasta snow-wreath.

Other Natural Occurrences or Human-related Activities

Shasta snow-wreath faces a number of significant threats to its persistence from reproductive and life-history challenges. The low genetic diversity of Shasta snow-wreath populations makes it less adaptable to changing environmental conditions or other factors, such as disease or climate change. Limited dispersal mechanisms of

Shasta snow-wreath due to the lack of reproduction from seed and the steep topographical impediments of the area severely restrict Shasta snow-wreath from dispersing to new habitats, making it more susceptible to population reductions or extirpations resulting from climate change or other disturbances. The perennial, long-lived nature of Shasta snow-wreath, together with its isolated populations and low dispersal capabilities, creates a scenario where extinction debt is also a possible phenomenon for this species, and human-induced threats may accelerate the pace towards extinction.

Shasta snow-wreath habitat is also threatened by climate change. As the climate system warms, potentially suitable habitat is expected to shift upwards in elevation, and suitable Shasta snow-wreath habitat will likely be reduced. Shasta snow-wreath faces severe limitations to dispersal and range shift since it is only known to reproduce through vegetative means, and it grows in areas of steep terrain with topographical impediments to dispersal.

Chance events, such as the inadvertent application of herbicide during efforts to control interspersed non-native species or failure to implement specified protective measures for land management activities are possible and present an additional threat to Shasta snow-wreath.

The Department considers other natural occurrences or human-related activities described above to be a significant threat to the continued existence of Shasta snow-wreath.

SUMMARY OF KEY FINDINGS

Shasta snow-wreath is a rare species that is only known from 26 populations near Shasta Lake. The populations vary in extent and were likely larger and more connected prior to the construction of Shasta Dam and the filling of Shasta Lake in the 1940's. Shasta snow-wreath has demonstrated very low genetic diversity within populations, Populations seemingly comprised of hundreds to thousands of plants could actually be comprised of clones of as few as 1-15 genetically distinct individuals within each population. When considering the number of genets or actual individuals, Shasta snow-wreath populations are quite small. Species with small population sizes are highly vulnerable to extinction due to stochastic (chance) demographic, environmental, and genetic events. In addition, populations with low genetic diversity are vulnerable to extirpation due to changing environmental conditions, and the threat of climate change compounds this risk for Shasta snow-wreath. Shasta snow-wreath appears incapable of reproducing by seed, limiting its ability to expand into nearby habitat, which threatens its persistence, especially with the predicted changing climate. Extinction debt is also a

possible phenomenon for Shasta snow-wreath, which is considered a relict species, or a "living fossil" remaining from a formerly more widespread group whose close relatives have gone extinct.

Populations of Shasta snow-wreath are threatened by the encroachment of aggressive invasive species, such as Himalayan blackberry and Scotch broom. In addition, the proposed project to raise Shasta Dam would result in a rising lake level that would inundate portions of half of the known Shasta snow-wreath populations. Although the area of impact from the proposed project to raise Shasta Dam is small, any impacts could result in a loss of important genetic diversity of Shasta snow-wreath and increase its vulnerability to extinction.

Shasta snow-wreath faces a number of threats to its survival. An endangered species is one that is in serious danger of becoming extinct throughout all or a significant portion of its range (Fish & G. Code, § 2062), and a threatened species is one that, although not currently faced with extinction, is likely to become an endangered species in the foreseeable future in the absence of protection by CESA (Fish and G. Code § 2067). Although Shasta snow-wreath is not currently faced with extinction, it is at risk from invasive plants, inability to reproduce and disperse by seed, stochastic (chance) events due to low genetic diversity and small population sizes, modification or destruction of habitat, and potentially from effects of altered fire regime and climate change, and it could become an endangered species in the foreseeable future. The information available to the Department regarding the status of Shasta snow-wreath indicates that there are significant threats to the continued existence of the species.

RECOMMENDATION FOR PETITIONED ACTION

CESA directs the Department to prepare this report regarding the status of Shasta snow-wreath in California based upon the best scientific information available to the Department (Fish & G. Code, § 2074.6). CESA also directs the Department to indicate in this Status Review whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). In addition to evaluating whether the petitioned action to list Shasta Snow-wreath as endangered is warranted, the Department also considered whether listing the species as threatened under CESA is warranted.

Under CESA, an endangered species is defined as "a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (Fish & G. Code, § 2062). A threatened species is defined as "a native species

or subspecies…that although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [CESA]" (Fish and G. Code § 2067).

The Department includes and makes its recommendation in this Status Review as submitted to the Commission in an advisory capacity based on the best available science. Based on the criteria described above, the best scientific information available to the Department indicates that Shasta snow-wreath, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by CESA. The Department recommends that listing Shasta snow-wreath as threatened under CESA is warranted at this time.

PROTECTION AFFORDED BY LISTING

It is the policy of the state to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052). If listed under CESA, unauthorized "take" of Shasta snow-wreath will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of statewide concern. As noted earlier "take" is defined under CESA as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (*Id.*, § 86). Any person violating the take prohibition would be punishable under state law. The Fish and Game Code provides the Department with related authority to authorize "take" under certain circumstances (*Id.*, §§ 2081, 2081.1, 2086, 2087, 2089.6, 2089.10 and 2835). As authorized through an incidental take permit, however, impacts of the taking of Shasta snow-wreath caused by the activity must be minimized and fully mitigated according to state standards.

Additional protection of Shasta snow-wreath following listing would also occur during required public agency environmental review under CEQA, and its federal counterpart, NEPA. CEQA and NEPA both require affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, threatened, and rare special status species. Under CEQA's "substantive mandate," for example, state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate, and the Department's regulatory jurisdiction generally, the Department expects related CEQA and NEPA review will likely result in increased information regarding the status of Shasta snow-wreath in California and result in updated occurrence and abundance information for individual projects. Where significant impacts are identified under CEQA, the Department expects project-specific required avoidance, minimization and mitigation measures will also benefit the species. While both CEQA and NEPA would require

analysis of potential impacts to Shasta snow-wreath regardless of its listing status under CESA, the laws contain specific requirements for analyzing and mitigating impacts to listed species. In common practice, potential impacts to listed species are examined more closely in CEQA and NEPA documents than potential impacts to unlisted species. State listing, in this respect, and required consultation with the Department during state and local agency environmental review under CEQA, is also expected to benefit the species in terms of related impacts for individual projects that might otherwise occur absent listing.

If Shasta snow-wreath is listed under CESA, it may increase the likelihood that state and federal land and resource management agencies will allocate funds towards protection and recovery actions. However, funding for species recovery and management is limited, and there is a growing list of threatened and endangered species. Listing under CESA would also increase Shasta snow-wreath's eligibility for recovery or scientific research grants. Lastly, in common practice, many efforts (e.g., policy and regulation development, staffing allocations) prioritize listed species.

MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES

CESA directs the Department in its Status Review to recommend management activities and other recommendations for recovery of Shasta snow-wreath (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). The utility of current data on Shasta snow-wreath is limited by being largely anecdotal and qualitative. Studies designed to provide quantitative data on Shasta snow-wreath populations and the factors that affect the potential for Shasta snow-wreath to survive and reproduce are necessary for species management and conservation. Department staff generated the following list of recommended management actions and recovery measures to achieve conservation of Shasta snow-wreath. The Department recommends that the following actions be coordinated by the U.S. Forest Service as the primary land manager, in cooperation with private landowners, the U.S. Fish and Wildlife Service, the Department, researchers, and tribal and other partners.

- Convene a working group or recovery team to complete and implement a recovery plan for Shasta snow-wreath in collaboration with the U.S. Fish and Wildlife Service (Fish & G. Code § 2079.1);
- Research the reproductive system of Shasta snow-wreath, specifically factors related to self-compatibility, pollination, seed viability, germination, and recruitment, to inform potential future introductions or population expansions;
- Conduct additional research on genetic diversity within and between all known Shasta snow-wreath populations;

- Implement an invasive species early detection and removal program at Shasta snow-wreath populations where invasive species are not yet established;
- Implement an invasive species removal program to control Himalayan blackberry, Scotch broom, and other aggressive invasive species at Shasta snow-wreath populations with established infestations;
- Conduct habitat modeling using geographic information systems or another comparable method to determine the locations of suitable habitat in and around the current range of Shasta snow-wreath, and conduct focused surveys for additional populations/occurrences;
- Collect and propagate Shasta snow-wreath cuttings from individual genets and maintain plants in living collections at CDFW-permitted botanical gardens to conserve the species' genetic diversity;
- Design and implement a standardized, range-wide search for Shasta snow-wreath seedlings throughout its habitat;
- Design and implement population monitoring and adaptive management programs for the Shasta snow-wreath populations to determine if habitat suitability or occupied habitat is being reduced or remaining stable. Ensure that monitoring results trigger appropriate management responses such as implementing other measures to control invasive species or controlling recreational activities. Make the data and reports from monitoring and adaptive management programs available to resource agencies and to those who are directly involved in Shasta snow-wreath management;
- Implement a program to detect Shasta snow-wreath population trends using statistically-valid population estimates.

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APPENDIX A: Summary of Shasta Snow-wreath Populations and Threats

Summary of Shasta Snow-wreath (*Neviusia cliftonii*) Populations and Threats

([USDI BOR] United States Department of the Interior, Bureau of Reclamation 2015; CNDDB 2021; Digital Map Products 2021)

CNDDB Occurrence #	Population Name	Size (acres)	Estimated Population Size (Ramets)**	Year(s) of Population Estimate(s)**	Ownership	Notable Threats/Notes
1	Cedar Creek	Not available	Not available	N/A	State of California	Himalayan blackberry (*Rubus armeniacus*) occurs in and near the population (Departmental observation 2021).
2	Squaw Creek	19.6*	Not available	N/A	USFS-Shasta-Trinity National Forest, Private	Himalayan blackberry occurs near the population and is prevalent in the vicinity (Lindstrand pers. comm. 2020).
3	Ellery Creek/South of Ellery Creek (former EO #4)	41.85*	1000s	2019	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam; population is surrounded by Himalayan blackberry and Scotch broom (*Cytisus scoparius*). Includes former CNDDB element occurrence #4.
4	N/A					Subsumed into CNDDB element occurrence #3
5	Curl Creek	33.07*	1729	2011–2013	USFS-Shasta-Trinity National Forest	
6	Campbell Creek	1.9*	1022	2011–2013	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam; Himalayan blackberry occurs near the downstream-most portion of the population and could potentially spread.
7	Low Pass	51.9*	11,708	2011 - 2013	USFS-Shasta-Trinity National Forest	Occurrence is found along both sides of a historic jeep trail that is functionally a foot trail. Invasive Himalayan blackberry present within and adjacent to the population.

CNDDB Occurrence #	Population Name	Size (acres)	Estimated Population Size (Ramets)**	Year(s) of Population Estimate(s)**	Ownership	Notable Threats/Notes
8	Bear Gulch	<8.8^	1000–1500	2019	Private (Stimpel-Wiebelhaus and Sierra Pacific Industries [SPI])	Extensive Himalayan blackberry growth occurs along the Bear Gulch corridor, including plants within and near the Shasta snow-wreath population.
9	Mountain Gate	Not available	Not available	N/A	Private (Mountain Gate Quarry)	No determination of specific threats can be assessed. Near an active gravel quarry. Threats from invasive species is assumed due to the prevalence of Himalayan blackberry throughout the area.
10	Cove Creek/South of Cove Creek	1.33*	1000s	2006	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
11	Ripgut Creek	0.18*	100	2003	USFS-Shasta-Trinity National Forest	
12	Stein Creek	≤42.15^+	716 to "thousands"	2010; 2011–2012	USFS-Shasta-Trinity National Forest, and Private (SPI)	Inundation from the project to raise the height of Shasta Dam. Extent of population may be less than 42.15 acres. A portion of the population was mapped for the Shasta Dam raise EIS using total station surveying, but other patches were calculated using the CNDDB shapefiles, which include a buffer. Timberland management activities occurred within the population historically and during 2012-2015. 716 average ramet population size in 2011-2012. Includes former CNDDB element occurrence #13.
13	N/A					Subsumed into CNDDB element occurrence #12.
14	Waters Gulch	10.88*	20,100	2011–2013	USFS-Shasta-Trinity National Forest	Trail maintenance; Himalayan blackberry and Scotch broom occur in the population.

CNDDB Occurrence #	Population Name	Size (acres)	Estimated Population Size (Ramets)**	Year(s) of Population Estimate(s)**	Ownership	Notable Threats/Notes
15	Keluche Creek	0.15*	500–1000	2003	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
16	Blue Ridge	1.17*	4585	2011–2013	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam; Himalayan blackberry present in the population.
17	Flat Creek	2.67*	1000s	2007	USFS-Shasta-Trinity National Forest	
18	Brock Creek	1.38*	100+	2004	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
19	Stein West	4.92*	1000s	2006	USFS-Shasta-Trinity National Forest	
20	Shasta Caverns	0.08*	<100	2007	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
21	Jones Valley	0.34*	3878	2011–2013	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam; Himalayan blackberry occurs within and near the population.
22	Manzanita Hill	0.69‡	500–1000	2012, 2019	Private – SPI	Plants are outside of the timber harvest unit and will be protected within an SPI Habitat Retention Area (HRA) and a Watercourse and Lake Protection Zone (WLPZ). Himalayan blackberry present in the population.

CNDDB Occurrence #	Population Name	Size (acres)	Estimated Population Size (Ramets)**	Year(s) of Population Estimate(s)**	Ownership	Notable Threats/Notes
23	McCandless Gulch	18.8*	5000–7100	2012, 2014	Private – SPI	Timber harvest activities occurred in 2014-2015. Himalayan blackberry present.
24	East of Stein Creek	Not available	20–30	2015	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
25	North of Marble Creek	1.37*	1700–2275	2014	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
26	Allie Cove	0.04*	150–200	2015	USFS-Shasta-Trinity National Forest	
27	Bear Canyon	Not Available	1500–2000	2016	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.
28	Roberts Canyon	Not available	300–400	2016	USFS-Shasta-Trinity National Forest	Inundation from the project to raise the height of Shasta Dam.

CNDDB = California Natural Diversity Database
**Some CNDDB occurrences document population estimates for multiple years, and some estimates are from partial surveys or a portion of the occurrence. "Estimated Population Size (Ramets)" in this table is the most recent and complete estimate for an occurrence, and "Year(s) of Population Estimate(s)" corresponds with the estimate used in the table.
*Source: Detailed digital mapping data submitted to the CNDDB in shapefile format.
^Source: CNDDB shapefile. The CNDDB mapped polygons include a buffer. Therefore, the areas of the CNDDB polygons are larger than the actual extent of each population.
⁺Source: SLWRI EIS
‡Source: CNDDB description.

APPENDIX B: Comments from Affected and Interested Parties on the Petitioned Action

APPENDIX C: External Peer Review Invitation Letters and Comments from Peer Reviewers on the Shasta Snow-wreath Status Review Report