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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

September 30, 2019

KATHLEEN S. ROCHE

NOTICE OF PETITION

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) (California Code 2019) and Sections 2072 and 2073 of the Fish and Game Code (California Fish and Game Code 2019) relating to listing and delisting endangered and threatened species of plants and animals.

I. SPECIES BEING PETITIONED:

Common Name: Shasta snow-wreath

Scientific Name: *Neviusia cliftonii*

II. RECOMMENDED ACTION

To list as Endangered under the California Endangered Species Act (CESA) (California Code 2019 and California Fish and Game Code 2019).

> CCR § 2062. Endangered species
> "Endangered species" means 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. Any species determined by the commission as "endangered" on or before January 1, 1985, is an "endangered species."

I, Kathleen S. Roche, submit this petition to the California Fish and Game Commission (CFGC) to list the Shasta snow-wreath (*Neviusia cliftonii*) as “endangered” in California, under the California Endangered Species Act (California Fish and Game Code §§ 2050 et seq.[California Code 2019 and California Fish and Game Code 2019]) (“CESA”). This petition demonstrates that the Shasta snow-wreath clearly warrants listing under CESA based on factors specified in the statute. The California Native Plant Society (CNPS) has reviewed this petition and the CNPS Rare Plant Program Committee has assessed the petition’s scientific validity by evaluating the accuracy of information regarding taxonomy, ecology, life history, and demographic data presented herein. The CNPS Conservation Program Committee has assessed the petition’s

conservation merits by evaluating threats, stressors, and management information applicable to this species. Based upon their review of these factors, CNPS finds the current status of *Neviusia cliftonii* to merit consideration for listing as Endangered under the California Endangered Species Act. Therefore, the California Native Plant Society endorses this petition and should be considered a co-sponsor of this effort. We look forward to the Commission's response to this petition and processing of it pursuant to the procedures and timelines established at California Fish and Game Code §§ 2073 et seq. (CNPS 2019).

III. AUTHOR OF PETITION

Name: Kathleen S. Roche
Address:
Phone:
Email:

I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete. All photos used with permission.

Date: September 30 2019: Kathleen S. Roche.

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EXECUTIVE SUMMARY

The Shasta snow-wreath (*Neviusia cliftonii*) is a dicot, shrub in the rose family (Rosaceae) that is native to California and is endemic (limited) to northern California. The inflorescence is an umbel-like cluster of 3 to 5 flowers. The flower is a ball of about 50 long, whiskery white stamens each about half a centimeter long. There are sometimes white petals surrounding the stamens, although the petals are often absent.

The species was first described in 1992 and is now known from a total of 24 occurrences, restricted almost entirely to National Forest System lands with 6 out of 24 occurrences not, or not completely, on federal land. It is found exclusively in western Shasta County around the perimeter of Shasta Lake in northern California.

Shasta snow-wreath is one of only two species in the genus *Neviusia*. The other species within the genus is *Neviusia alabamensis*, a rare endemic of the southeast U.S. There are no other species of *Neviusia* in California nor adjacent states. There is agreement on the classification and the scientific name of this species (California Natural Diversity Database of the California Department of Fish and Wildlife (CDFW), CNPS Calflora, NatureServe, USDA Plants Database Heikens and Ertter 2019 in Jepson eFlora, Phipps 2019 in the Flora of North America). The California Fish and Game Commission (CFGC) has not previously reviewed this species for listing. A petition is also being submitted to US Department of Interior Fish and Wildlife Service (USFWS) for listing under the US Endangered Species Act (ESA).

Shasta snow-wreath remained unrecognized so long because its flowers, the most distinguishing feature, only appear for a week to 10 days in late April or early May. When not in flower, the plant resembles common shrubs such as oceanspray (*Holodiscus discolor*) and ninebark (*Physocarpus capitatus*).

There is very little empirical data about the response of Shasta snow-wreath to various management techniques, including response to fire. To learn more, permanent monitoring plots were established in 2011-2012 to better understand the ecology, response to disturbances such as

fire, and long-term viability of this endemic species. Results of the monitoring were published in 2017.

Nearly all occurrences of Shasta snow-wreath occur on lands that are actively managed. There is one occurrence in a Research Natural Area (RNA) on the Shasta-Trinity National Forest (STNF). The Shasta snow-wreath is classified as a Sensitive species by the United States Department of Agriculture (USDA) Forest Service (FS) and the United States Department of the Interior (USDI) Bureau of Land Management (BLM). That status applies to lands managed by the respective agencies. Six of the 24 occurrences are documented on non-federal lands (private or other) and are managed under the goals of the land owner.

Shasta snow-wreath is included on the California Department of Fish and Wildlife (CDFW) Special Vascular Plants, Bryophytes, and Lichens List, with a California Rare Plant Rank of 1B.2 (rare, threatened, or endangered in CA and elsewhere) but has no status under the California Endangered Species Act. The major action (raise Shasta Dam) that will modify habitat is proposed by the USDI Bureau of Reclamation (BOR) under the project name of Shasta Lake Water Resources Investigation (SLWRI).

The Shasta snow-wreath is threatened by four general factors as specified in California Endangered Species Act (CESA), and thus warrants state protection. The four factors specified under CESA are: Modification or curtailment of habitat or range; Overutilization; Disease and Predation; Existing Regulatory Mechanisms and Other Factors.

The species is threatened with significant **modification and curtailment of habitat**, as a result of the proposal to raise Shasta Dam, inundate (flood) additional acres and move other infrastructure. This inundation and other associated actions would affect **62 percent** of all known occurrences of the plant species (9 out of 24 occurrences by inundation plus 8 by other actions) of the entire known population of Shasta snow-wreath.

Additional curtailment of habitat is anticipated from other land management actions such as mining, road and trail maintenance and vegetation management such as prescribed fire (although some fire may be beneficial).

Habitat curtailment from other processes such as wildfire, landslides and climate change are anticipated. While some fire is expected to be beneficial, the parameters of what is beneficial and what is not are not documented or quantified.

Over utilization appears to be a minor factor as do **disease and predation**. The **existing regulations** are inadequate to reduce or prevent the proposed and on-going destruction of individuals and habitat and are not responsive to other factors that when added to the changes in habitat and occurrences are likely to lead to endangerment and or complete loss of this species. **Other natural and man-made factors** also appear to be minor factors at this time although climate change and geological instability as affected by expected changes in climate and wildfires are difficult to quantify at this time.

All of the four factors interact and pose a cumulative threat to the species.

INTRODUCTION

Shasta snow-wreath was not known to science until 1992, when it was discovered northeast of Redding, California, and described as a new species in *Neviusia*, previously a monotypic genus. Shasta snow-wreath remained unrecognized so long because its flowers, the most distinguishing feature, only appear for a week to 10 days in late April or early May. When not in flower, the plant resembles common shrubs such as oceanspray (*Holodiscus discolor* (Pursh) Maxim.) and ninebark (*Physocarpus capitatus* (Pursh) Kuntze) (Shevock et al. 1992).

Another factor that helped the wiry, deciduous shrub with soft, tooth-edged leaves remain anonymous to botanists is that it grows in places dominated by poison oak (*Toxicodendron diversilobum* ((Torr. & A. Gray) Greene) (Shevock et al. 1992). Its range is far from any university, in a geographic area that is poorly explored botanically, with fewer than average numbers of specimens on file at California herbaria. Unlike many new taxa that were collected numerous times but misidentified, there are no herbarium specimens of *Neviusia cliftonii* collected before 1992.

Shevock (1993a) indicates that "We decided to take advantage of the enthusiasm displayed by botanists in the new species and arranged an organized search for Shasta snow-wreath (Nelson 1993) to search for additional occurrences May Day weekend (April 30-May 2) in 1993."

Shasta snow-wreath is one of only two species in the genus *Neviusia*. The other species within the genus is *Neviusia alabamensis,* a rare endemic of the southeast U.S. There are no other species of *Neviusia* in California nor adjacent states. There is agreement on the classification and the scientific name of this species (California Natural Diversity Database -CNDBB-of the California Department of Fish and Wildlife-CDFW-2018a, Calflora 2019, NatureServe 2019, USDA Plants Database 2019, Heikens and Ertter 2019 in UCB Jepson eflora, Phipps 2019 in Flora of North America eflora). The common name used here follows Kartesz and Thieret (1991).

The planning process to raise Shasta Dam (SLWRI) (US GPO 1980) by the Bureau of Reclamation (BOR) has included vegetation mapping and botanical surveys in the area, increased the botanical interest and concern in the flora surrounding Shasta Lake, and resulted in documentation of many of the currently known Shasta snow-wreath sites (USDI BOR Mid-Pacific Region 2014a).

These surveys associated with the BOR proposal and additional surveys have documented 24 element occurrences (CNDDB 2018), with Jules et al. (2017) reporting 33 occurrences by splitting CNDDB element occurrences into sub-colonies.

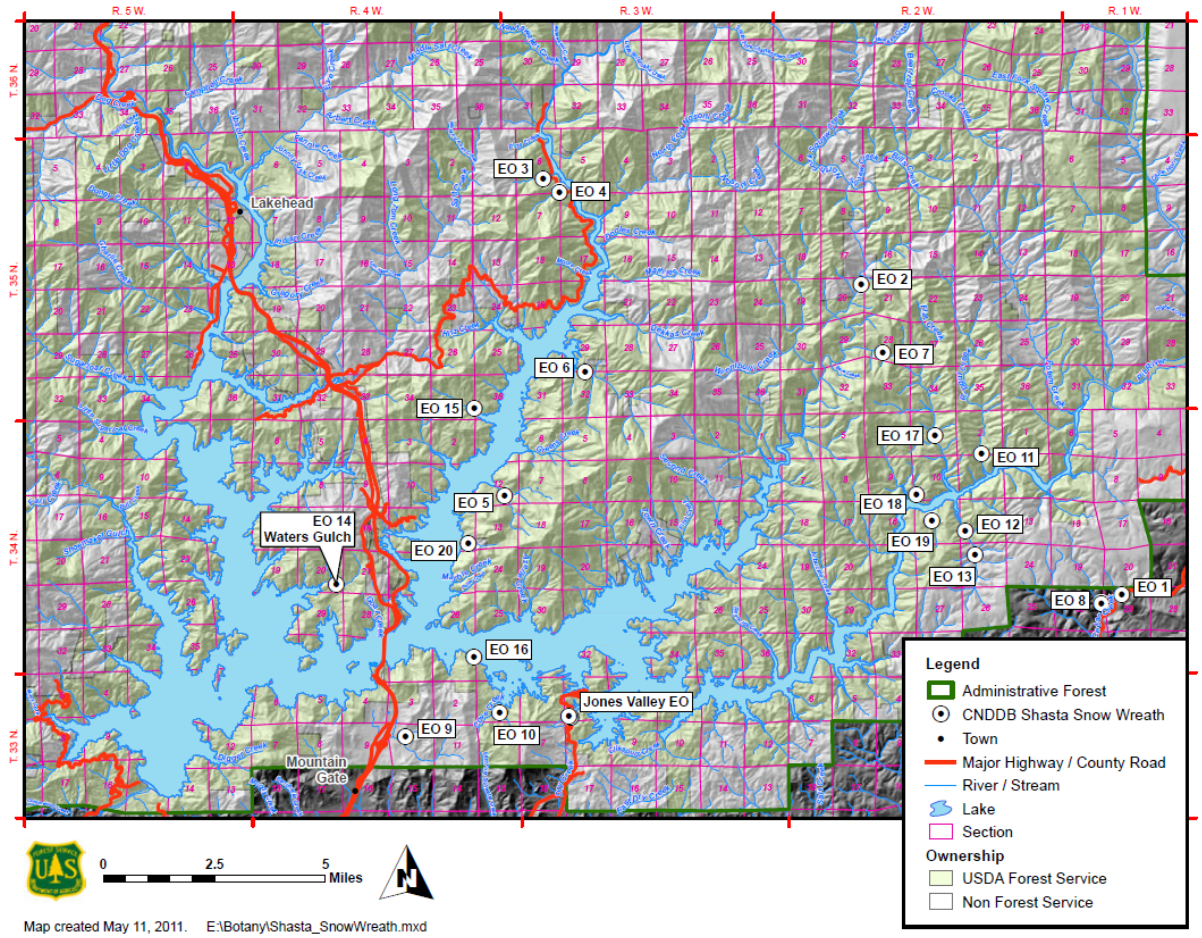
Shasta snow-wreath occurs within the Klamath Geomorphic province (USDI BOR 2014b) on Triassic age terrane (Cheng 1997, Ertter 1993). It was originally thought to occur only on limestone but is now documented to occur on other substrates (discussed in detail in following sections) (Lindstrand and Nelson 2005a, 2006). Permanent monitoring plots were established in 2011 in seven of the occurrences and an additional plot added in 2012 to better understand the ecology, response to disturbances such as fire, and long-term viability of this endemic species. These plots will be followed over time by the FS Regional Ecology Program and the Shasta-Trinity National Forest with the assistance of summer field crews hired through Humboldt State University. Shasta snow-wreath monitoring data was collected in 2011-2013 (personal communications Julie Kiersted Nelson 2013, Jules et al. 2017).

RANGE OF THE SPECIES

Shasta snow-wreath is endemic to California, occurring only near Shasta Lake in Shasta County. The total range covers about 250 square miles (NatureServe Explorer 2019; Lindstrand and Nelson 2005a, 2005b, 2006; DeWoody et al. 2012a; CNDDB 2018). There are now 24 documented element occurrences (DeWoody et al. 2012a, Lindstrand and Nelson 2005b, CNDDB 2018) (Figures 1 and 2, Table 1). Because of extensive searching between 1992-2016, it is unlikely that there will be many more occurrences discovered.

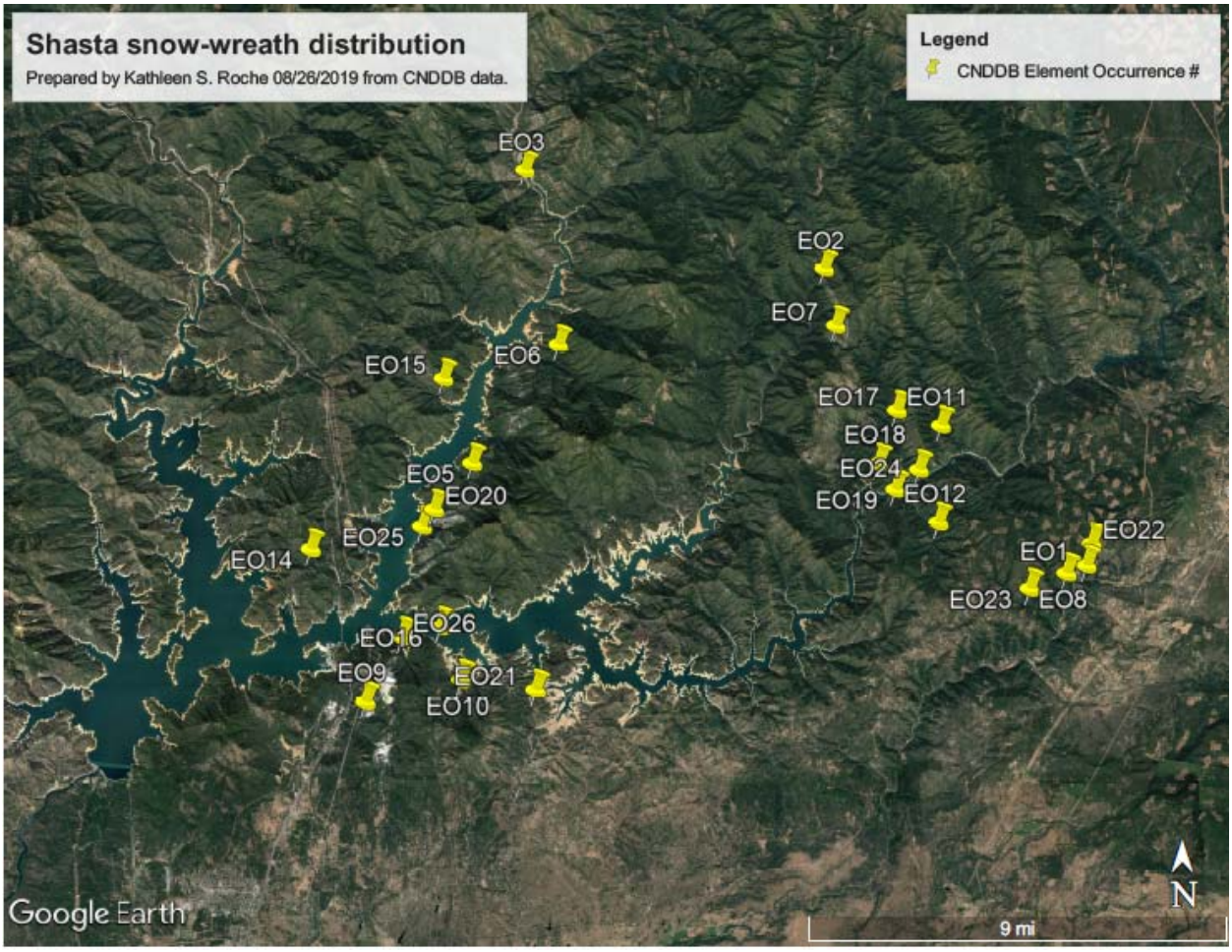
Shasta snow-wreath is presumed to have been more widespread and populations more connected along river corridors before the filling of Shasta Lake in 1948, as evidenced by the many populations that reach their lower limit at the full pool line of Shasta Lake (DeWoody et al. 2012a, Lindstrand and Nelson 2006). However, as a relict species, the geological history and resulting isolation of Shasta snow-wreath may have created an extinction debt because of time delays between the geological impacts on this species, such as destruction/isolation of habitat, and the species' potential disappearance (Jablonski 2002). The following images and table illustrate the distribution and other information about Shasta snow-wreath.

Figure 1. Shasta snow-wreath Map of Element Occurrences as of 2011.



Source: Julie Kiersted Nelson 2011, CNDDB Element Occurrences 2011. (EOs 3 and 4 have since been combined into EO3 following more extensive survey work. The EO labeled as Jones Valley is CNDDB EO 16.)

Figure 2. Distribution of Shasta snow-wreath 2019 Google Earth Image



Source: Kathleen S. Roche 2019a. Prepared from Google Earth Image 05/11/19 and CNDDB Element Occurrences 2018.

Table 1. Shasta snow-wreath Element Occurrences.

Element Occurrence #	Latitude	Longitude	Size * (acres)	Ownership	Threats
1	40.77779	-122.00175	18	Non-federal	Potential mining; the Hosselkus Limestone Formation is a high-quality source material for cement production. Fires. Inferred threats: climate change.
2	40.87811	-122.11119	30	Federal	Not specified in EO record. In dense vegetation near limestone outcrop. Inferred threats physical removal through mining or road construction, wildfire, climate change*
3	40.91327	-122.24473	71	Federal	Surrounded by invasive plants (*Rubus discolor* and *Cytisus scoparius*) in 1993. Burned over in Hirz fire 2018. Inferred threats: invasive plants, wildfire, climate change.
4	No EO	--	--	--	EO removed from CNDDB: subsumed into EO 3
5	40.81177	-122.26617	57	Federal	Not specified in EO record. Inferred threats: wildfire, climate change.

Element Occurrence #	Latitude	Longitude	Size * (acres)	Ownership	Threats
6	40.85209	-122.22906	8	Federal	Possibly threatened by logging in 1993. Road maintenance, raised lake level, and noxious weed invasion in 2010.
7	40.85834	-122.10675	72	Federal	Occurrence is found near a jeep trail. Inferred threats: physical removal, wildfire, climate change*.
8	40.77522	-122.01055	9	Federal and Private	Not specified in EO record. Inferred threats: wildfire, climate change.
9	40.73399	-122.30971	0	Non-federal	Close to mining and roads. Inferred threats: physical removal, sedimentation, invasive species*
10	40.74103	-122.26931	14	Federal	Not specified in EO. Inferred threats: inundation from Shasta Lake, wildfire, climate change*.
11	40.82440	-122.06182	2	Federal	Not specified in EO. Inferred threats: located in dense vegetation, wildfire, climate change.
12	40.79205	-122.06449	57	Federal and Private	Timber harvest proposed for area on private land in 2010 but protection measures will be used. Inferred threats wildfire, climate change, invasive species*.
13	No EO	--	--	--	EO removed from CNDDB: subsumed into EO 12
14	40.78327	-122.33507	28	Federal	Previous trail construction probably damaged/destroyed some plants (2001). scotch broom is encroaching (2010).
15	40.84056	-122.27950	2	Federal	Not specified in EO. Inferred threats: inundation from Shasta Lake, wildfire, climate change*.
16	40.75801	-122.27866	7	Federal	Not specified in EO. Inferred threats: inundation from Shasta Lake, wildfire, climate change*.
17	40.82959	-122.08078	7	Federal	Not specified in EO. Inferred threats: wildfire, climate change, possible disturbance from off-highway vehicles.
18	40.81183	-122.08952	5	Federal	Not specified in EO. Inferred threats: inundation from Shasta Lake, wildfire, climate change*.
19	40.80306	-122.08258	10	Federal	Not specified in EO. Inferred threats: located in dense vegetation, wildfire, invasive species, climate change*.
20	40.79646	-122.28237	2	Federal	Not specified in EO. Inferred threats: dense vegetation, wildfire, invasive species, climate change.
21	40.73776	-122.23778	4	Federal	Not specified in EO. Inferred threats: roads, wildfire, invasive species, climate change.
22	40.78480	-121.99920	3	Private	Plants are outside of the timber harvest unit and in the future will be protected within the water lake protection zone.
23	40.77019	-122.02665	38	Private	Portions of site may be threatened by blackberries choking out *Neviusia*. majority of population outside harvest unit.
24	40.80973	-122.07183	1	Federal	Not specified in EO. Inferred threats: inundation from Shasta Lake, wildfire, climate change*.
25	40.79080	-122.28739	8	Federal	Not specified in EO. Inferred threats: wildfire, invasive species, climate change, possibly inundation.
26**	40.75466	-122.29479	1	Federal	Not specified in EO. Inferred threats: mining, wildfires, invasive species, climate change.
Total			116		

Source: Kathleen S. Roche 2019. EO= Element occurrence.

**Acres are extracted from CNDDB Occurrence reports.*

*** Two occurrence were subsumed into other element occurrences. Total occurrences = 24.*

LAND OWNERSHIP AND MANAGEMENT DIRECTION

Of the 24 documented element occurrences, all but 6 occur entirely on National Forest System (NFS) Lands that are managed by the Shasta Lake Ranger District of Shasta-Trinity National Forest, United States Department of Agriculture Forest Service (Figure 1 and 2, Table 1, CNDDB 2018). Many of the occurrences on NFS lands are within the Whiskeytown–Shasta–Trinity National Recreation Area (NRA) as established by the U.S. Congress in 1965 (US GPO 1965). The emphasis of the NRA is to provide recreation associated with the reservoirs (lakes). The authorizing act, Public Law 89-336 also states in section 4(a)(3): "such management, utilization, and disposal of renewable natural resources as in the judgment of the respective Secretary will promote or is compatible with, and does not significantly impair, public recreation and conservation of scenic, scientific, historic, or other values contributing to public enjoyment."

One occurrence is within the Devil's Rock-Hosselkus Research Natural Area (DRH-RNA) of the Shasta-Trinity National Forest (USDA FS STNF1996, Cheng 1997). The DRH-RNA is managed for natural conditions as specified in the STNF LRMP (USDA FS STNF 1996) and FSM 4063 (USDA FS 2005). The DRH-RNA is 5,500 acres in size (Cheng 1997).

Six occurrences are partially or completely on non-federal or private lands (CNDDB 2018) and these lands are managed to meet land owner goals.

CHRONOLOGY OF PAST EVENTS AND INVESTIGATIONS

56-33.9 million years ago - Shasta snow-wreath thought to have originated (Ertter 1993, deVore et al. 2004, Stebbins 1993).

1735 - Carl Linnaeus publishes *Systema Naturae* and established the binomial system of naming species (Linnaeus 1756). Shasta snow-wreath scientific name, *Neviusia cliftonii*, conforms to this naming system.

1850–1945 - Bully Hill area is explored and developed for mineral deposits (Albers and Robinson 1961, Lydon and O'Brien 1974).

1858 - Asa Gray named *Neviusia* as a new genus of the Rose family (Gray 1858).

1906 - Studies in flower pollination (Knuth 1906) has discussion of other members pollination strategies in other members of this tribe of plants.

1908-1939 - Delmar railroad operates from Bella Vista to the town of Pitt in the vicinity of the current Shasta Lake and provides services to Bully Hill Mine (Smith 2012) introducing settlers to the area.

1935-1945 - Bureau of Reclamation purchases and reserves lands for Shasta Lake reservoir (Stene 1996).

1945 - Shasta Lake is filled and inundates more than 29,500 acres (11,938 ha) (DeWoody et al. 2012a, USDI BOR 2015).

1945-2018 - Road within DRH-RNA intermittently maintained.

1948 - 2018 (estimated) - Waters gulch trail maintained intermittently with some disturbance to Shasta snow-wreath plants.

1965 - Legislation to establish the Whiskeytown Shasta-Trinity National Recreation Area in the State of California, and for other purposes (US GPO 1965).

1990's (estimated) - Road slide out occurred within DRH-RNA.

1992 - Shasta snow-wreath plants discovered by Dean W. Taylor and Glenn A. Clifton in May and described in Winter 1992 issue of NOVON (Shevock et al. 1992).

1993 - Organized search for additional element occurrences (Nelson 1993).

1994 - Wehr and Hopkins identify *Neviusia* in fossils at Republic, Washington (Wehr and Hopkins 1994).

1999 - Shasta Lake Water Resources Investigation (USDI BOR 2019) begins to investigate raising the height of Shasta Dam.

2001 (estimated) - Waters gulch occurrence of Shasta snow-wreath affected by brushing associated with a wildland fire response but was not burned (personal communications Julie Kiersted Nelson 2016a).

2004 - DeVore publishes on Fossil *Neviusia* leaves in Okanagon Highlands in southern British Columbia Canada (DeVore et al. 2004).

2005 - Lindstrand and Nelson describe additional occurrences of Shasta snow-wreath in Fremontia (Lindstrand and Nelson 2005a).

2006 - Lindstrand and Nelson describe habitat, geologic, and soil characteristics of Shasta snow-wreath in Madroño (Lindstrand and Nelson 2006).

2011 - Monitoring plots established (Jules et al. 2017) prescribed fire in one location Silverthorn, south side of Shasta Lake, north of Bear Mountain (Newburn and Payne 2014).

2011 - Green-Horse Habitat Restoration and Maintenance project planning begins 05/23/2011 (USDA Forest Service 2015).

2012 - Monitoring of response to prescribed fire (Jules et al. 2017).

2014 - Green-Horse project Draft Environmental Impact Statement (DEIS) proposing vegetation management in the area (USDA Forest Service 2015) released for comment 11/05/14.

2015 - On July 29, 2015, the Bureau of Reclamation transmitted to Congress the Final Feasibility Report and Environmental Impact Statement for the Shasta Lake Water Resources Investigation (USDI BOR 2015). The report describes the potential technical, environmental, economic, and financial evaluations prepared to date for alternatives to raise Shasta Dam, located approximately 10 miles northwest of Redding, California. The report also identifies next steps to identify construction cost share partners and project financing and develop the Recommended Plan. The project is intended to increase water supply and water supply reliability for agricultural, municipal and industrial, and environmental purposes and increase survival of anadromous fish populations in the upper Sacramento River.

2015 - Green-Horse project Draft Record of Decision (ROD) and Final Environmental Impact Statement (FEIS) posted to Shasta-Trinity National Forest webpage in December (USDA FS 2015).

2016 - Green-Horse project Record of Decision (Myers 2016) signed November 17, 2016.

2017 - Jules et al. (2017) publish results of *Neviusia* monitoring.

2017 - Green-Horse project implementation begins.

2018 – Hirz fire burns through Element Occurrence 3 (USDA FS STNF 2018).

2019 – Invasive plant treatment completed at Packers Bay (EPIC 2019).

2019 - Petition for listing filed with FWS on September 30, 2019.

CONSERVATION STATUS

Regulatory

Shasta snow-wreath is included on the California Department of Fish and Wildlife Special Vascular Plants, Bryophytes, and Lichens List (CDFW 2018a,) and *CNPS Inventory of Rare and Endangered Plants* (CNPS Rare Plant Program 2019) with a California Rare Plant Rank of 1B.2 (rare, threatened, or endangered in CA and elsewhere); this ranking confers conservation

status under the California Environmental Quality Act. Shasta snow-wreath is not currently listed under the California Endangered Species Act (CDFW 2018b). The intent of this document is to have it added to this list.

Shasta snow-wreath is currently listed as sensitive by the USDA Forest Service, Pacific Southwest Region under the Regional Forester's Sensitive Species list (USDA FS R5 2013, USDA FS 2005a in FSM 2670) and by the USDI BLM (2015) for California (USDI BLM 2015). Sensitive species are managed to avoid a trend towards federal listing (USDA FS 2005a in FSM 2670).

As Forest Plans are updated to the 2012 Planning Rule standards (USDA FS 2012), the Shasta-Trinity National Forest may, or may not, include Shasta snow-wreath in its "species of conservation concern (SCC)" list. Once this occurs management on the forest would then no longer be subject to the Regional Forester's Sensitive Species list. After revision, new Forest Plan components would address its status as a species of conservation concern. The SCC list will at least partially use NatureServe rankings. The NatureServe rankings (NatureServe Explorer 2019) for Shasta snow-wreath are:

- Global G2 – Imperiled,
- National N2- Imperiled,
- State of CA S2 – Imperiled.

The state status would also be considered in the evaluation of species of conservation concern as the Shasta-Trinity National Forest - Forest Plan is revised and is considered in any status for BLM public lands.

Shasta snow-wreath occurs within the Devil's Rock-Hosselkus Research Natural Area (DRH-RNA) as currently established. Research Natural Areas are managed for natural conditions. This status as an RNA could be revised with the Forest Plan Revision with the completion of additional environmental analysis specific to that status (Cheng 1997, USDA FS 2005b). The DRH-RNA has one occurrence of Shasta snow-wreath.

This petition information is being concurrently submitted to the CFGC and USFWS (Roche 2019b,c). For species listed under the Federal Endangered Species Act, the USFWS would be

consulted for plan components and project actions that may affect the listed species and/or its critical habitat.

Draft conservation strategy

Currently, there are no known draft conservation strategies other than the Forest Service Sensitive species status which applies to 19 occurrences and the Devils Rock-Hosselkus Research Natural Area policy and direction which applies to one occurrence.

Past Conservation Efforts

Shasta snow-wreath has been, and likely continues to be collected by botanists and gardeners for growing in personal gardens (reduced to possession—removed from federal ownership and committed to private ownership/possession).

Some of the Shasta snow-wreath material that has been removed from the wild might also provide for off-site conservation. The Dunsmuir Botanical Gardens in Dunsmuir, California has at least 2 specimens growing there. Located in the Dunsmuir City Park in far northern California, the Gardens encompass ten acres of hilly, wooded area with a meadow containing the various gardens. The purpose of the Dunsmuir Botanical Gardens is to enhance the natural setting of the Dunsmuir City Park for the enjoyment and horticultural education of the public through the establishment and maintenance of native and woodland plants (Dunsmuir Botanical Gardens 2014) Ertter and Shevock (1993) indicate that Members of the California Native Plant Society currently are cultivating *N. cliftonii* and that it is growing at East Bay Regional Parks Botanical Garden. Christman (2011) also documents nearby cultivation locations, while Breen (2019) and Tu (2019) document Shasta snow-wreath growing at the Hoyt Arboretum in Portland, Oregon since 1999. The California Native Plant Society, CNPS Calscape (2019) and Calflora (2019) indicate the species is occasionally available from nurseries commercially.

None of the Shasta snow-wreath is currently designated as a scientifically documented genetic resource of conservation value. There are no other known past conservation efforts other than this informal, non-systematic off-site conservation from those who have cuttings of this plant.

POPULATION STATUS

A population is a group of organisms of one species that interbreed and live in the same place at the same time (Biology 2019a).

Demographics

Demographics describe the size, structure, and distribution of a population, and spatial or temporal changes in response to birth, migration, aging, and death. Elzinga et al. (1998) indicate that a population's demographic distribution is the percentage of the population or number of individuals within classes such as seedling, non-reproductive adult, reproductive, and senescent. There is little knowledge of any age classes of Shasta snow-wreath. There are now 24 documented element occurrences (DeWoody et al. 2012a, CNDDB 2018, Lindstrand and Nelson 2005). All of those comprise adult flowering occurrences with some degree of relatedness – e.g. of clonal origin. There are pictures of achenes. There is no confirmed documentation of seedlings. All plants grown in cultivation are clonal (from cuttings).

Population Record

The most complete population records are contained in the California Natural Diversity Database (CNDDB 2018) and discussed in DeWoody et al. (2012a). There are now 24 documented element occurrences (DeWoody et al. 2012a, Lindstrand and Nelson 2005b, CNDDB 2018). Because of extensive searching between 1992-2016, it is unlikely that there will be more occurrences discovered. Searches included those specific to Shasta snow-wreath and project surveys by the USDA Forest Service, Shasta-Trinity National Forest and occurred within the known distribution and beyond (personal information).

Jules et al. (2017) established monitoring plots starting in 2011 and report baseline information in their 2017 publication.

Viability

Viability is regarded as ability to survive or live successfully (Biology 2019b). The persistence of a population (population viability) into the future is based on many factors including the genetics, biology and natural history of the species, the natural disturbance elements of the area it

inhabits and anthropogenic factors that may directly threaten the persistence or may change the frequency or severity of natural disturbances and thus reduce persistence on the landscape.

Since there are no verified seedlings of Shasta snow-wreath, and there is a lack of information regarding the possible life stages, there is no opportunity to do a population viability analysis. Seed collected in 1992, did not germinate under any of the tested regimes at the University of California Botanical Garden (Ertter and Shevock 1993). There are no other reports of seed collected or of reproduction or viability testing. Achenes are known from photographs and from the type description. Achenes (seed structures) are known from photographs (Puentes 2011, Doyen 2015, Ertter and Shevock 1993) and the formal species description (Shevock et al. 1992).

De Witte and Stöcklin (2010) indicate that species' life-history and population dynamics are strongly shaped by the longevity of individuals, but life span is one of the least accessible demographic traits, particularly in clonal plants. Continuous vegetative reproduction of genets enables persistence despite low or no sexual reproduction, affecting genet turnover rates and population stability. Genet size is sometimes used to estimate age and there is some information available on genet size for Shasta snow-wreath. However, for quaking aspen, *Populus tremuloides*, molecular divergence detected by microsatellites was related to clone age with the help of demographic models of ramet and genet dynamics and indicated that genet size actually is not related to life span (De Witte and Stöcklin 2010).

The plants currently in existence are of unknown age but the species is considered a fossil species (Ertter 1993, Stebbins 1993).

Mortality

Historically, it is thought that populations were lost with the filling of Shasta Lake in 1948, as evidenced by the many populations that reach their lower limit at the full pool line of Shasta Lake (DeWoody et al. 2012a, Lindstrand and Nelson 2006). Monitoring of current populations began in 2011-2012 (Jules et al. 2017). There is no other documentation of loss of an Element Occurrence. There are two element occurrences that have been combined with other element occurrences as better data became available.

Informal observations (Nelson and Roche 2016) indicate that plants re-sprout from roots after some types of disturbances.

Shasta snow-wreath monitoring data was collected in 2011-2013 and published in 2017 (Jules et al. 2017). This on-going monitoring may provide information on persistence and mortality.

Population viability analysis:

Since there are no confirmed seedlings of Shasta snow-wreath, and incomplete information about longevity, there is no opportunity to do a population viability analysis.

Population expansion:

Shasta snow-wreath currently suffers from an inability to expand its range due to its relict status, lack of successful sexual reproduction, topographic limitations and associated climate differences and its ties to particular geological substrate/ancient terrane. It is surmised that, in the past, it was more widely distributed (DeVore et al. 2004).

It appears likely that the existing extent of the meta-population represents the potential extent of the entire meta-population.

NATURAL HISTORY

From the data available, Shasta snow-wreath appears to be an endemic, relict, long-lived, clonally propagated shrub that does occasionally produce seeds, apparently from sexual reproduction but those seeds are not confirmed to germinate in the wild or in attempts to propagate (Doyen 2015, Puentes/SPI 2011, Julie Kiersted Nelson personal communications 2016a, Erttter and Shevock 1993).

Fire and/or smoke has been documented to influence germination in a number of shrub species (Keeley 1987) and might be an influence for Shasta snow-wreath.

The following sections will discuss these characteristics in more detail.

Taxonomy and Species Description

The Shasta snow-wreath (*Neviusia cliftonii* Shevock, B. Ertter & D.W. Taylor) is a dicot, shrub in the rose family (Rosaceae) within the tribe Kerrieae.

The following information is from the Integrated Taxonomy Information System (ITIS 2016):

Kingdom	Plantae – plantes, Planta, Vegetal, plants
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta – land plants
Superdivision	Embryophyta
Division	Tracheophyta – vascular plants, tracheophytes
Subdivision	Spermatophytina – spermatophytes, seed plants, phanérogames
Class	Magnoliopsida
Superorder	Rosanae
Order	Rosales
Family	Rosaceae – roses
Genus	Neviusia A. Gray – snow-wreath
	Direct Children:
Species	*Neviusia alabamensis* A. Gray – Alabama snow-wreath
Species	*Neviusia cliftonii* Shevock, Ertter & D.W. Taylor – Shasta snow-wreath

Shasta snow-wreath is thought to have established as a species about 56 to 33.9 million years ago based on landform, geologic age (Ertter 1993, Stebbins 1993).

Shasta snow-wreath was not known to science until 1992, when it was discovered northeast of Redding, California, and described as a new species in *Neviusia*, previously a monotypic genus (Shevock et al. 1992, Taylor 1993).

Shasta snow-wreath appears to be most closely related to Alabama snow-wreath (*Neviusia alabamensis)* a similar relict species located in the Southeastern United States (Shevock et al. 1992). The relictual nature of both species is thought to be associated with the ancient landforms that provide the respective habitat for each species. Adding to the science in support of the

relictual nature is recent identification of *Neviusia* fossils in the Okanagon Highlands of Washington (DeVore and Pigg 2007, DeVore et al. 2004, 2005, Wehr and Hopkins 1994).

In 1857, Asa Gray named *Neviusia* as a new genus of the Rose family, based on material from Alabama supplied by the Rev. Dr. Reuben Denton Nevius (Howard 1976, Gray 1857). *Neviusia* was placed in the tribe Kerriae, which at the time, it shared with two Asiatic genera, each with only a single species: *Kerria japonica* and *Rhodotypos scandens*. Potter et al. (2007) in a further study places fourth monotypic genus, *Coleogyne* in the Kerria tribe as well (Shevock 1993b).

Even though this part of Shasta County California was explored and settled in the 1850s and botanists traveled through it occasionally, Shasta snow-wreath remained incognito so long because its flowers, the most distinguishing feature, only appear for a week to 10 days in late April or early May. When not in flower, the plant resembles common shrubs such as oceanspray and ninebark (Shevock et al. 1992).

Description of Shasta snow-wreath from Shevock et al. (1992):

> "Diffuse slender-branched understory shrub, stems erect, generally several, rarely > 1cm diameter, the bark grayish near base, ± reddish brown above, ± exfoliating in strips, without obvious lenticels, herbage and young twigs ± strigose, the hairs ± 0.4 mm long; leaves alternate, primarily in upper 1/3 of plant, generally expanded at anthesis, the stipules linear-setaceous, free from the 4-10 (-15) mm-long petiole, often with small reddish glands, the leaf blade ovate to cordiform, 2-6(9 on sterile shoots) cm long, 1.5-5 (7) cm wide, ± bicolored, bright green and sparsely strigose above, pallid and more densely strigose below, the venation craspedodromos with 3-8 2° veins per side, the margin coarsely toothed and shallowly lobed, the teeth apiculate; inflorescence ± umbellate-corymbose, terminal mostly on short side branches, not otherwise pedunculate, the pedicels 1-3 cm long, very slender, *ca.* 0.3 mm thick (widening above); flowers(1-) 3-5 (-10), appearing after or with the leaves, the hypanthium ± flat, ± glabrous 2-3 mm diameter (pressed); sepals 5-6 ± obovate 3.5-6 mm long, 2-4.5 mm wide, veiny, irregularly few toothed distally, spreading at anthesis, persisting in fruit; petals oblanceolate, 4-8 mm long, white, quickly deciduous; stamens many, *ca.* 50 or more, *ca.* equaling sepals, the filaments 4-5 mm long, white, ± dilated, the anthers round, 0.3-0.4 mm long, yellow; pistils 3-6, the ovary densely white-strigose, the style ± 3 mm long,

sparsely strigose; fruit ± eccentrically ovoid achene, 3-4 mm long, brown, sparsely strigose."

Shasta snow-wreath is currently known to clonally propagate (please also see following section on genetics). It occasionally produces achenes (Puentes 2011, Doyen 2015, Shevock et al. 1992, Ertter and Shevock 1993), apparently from sexual reproduction but the seeds within are not confirmed to germinate in the wild or in attempts to propagate (personal communications Julie Kierstead Nelson 2016b, Ertter and Shevock 1993).

Figure 3. Shasta snow-wreath (Neviusia cliftonii) achenes.

Source: Stephanie Puentes 2011 © SPI from CalPhotos

Figure 4. Shasta snow-wreath achenes

Source: John Doyen 2015 © John Doyen from CalPhotos.

It is currently unknown as to whether the seeds are produced from selfing (fertilization by means of pollen from the same plant) or from cross pollination (see also following section on pollination). Knuth (1906) indicates that Alabama snow wreath (*Neviusia alabamensis*) and Japanese Kerria (*Kerria japonica)* are both self-sterile (the effect of pollen on the stigma of the same flower is inactive). In the 26 years of observation by botanists, no recently germinated seedlings have been confirmed (Nelson 2016b). The reproductive biology of the native populations of Shasta snow-wreath is little understood.

The known occurrences may, in actuality, be one or several very large clone(s) (see following section on genetics for more information on Shasta snow-wreath relatedness). Alabama snow-wreath, a similar closely-related species, grows as a suckering shrub up to six feet in height and, under ideal conditions, can produce dense thickets up to several yards across. The suckering habit may be the only means of replication that Alabama snow-wreath employs (Chafin and Owers 2010).

Since there are no confirmed seedlings of Shasta snow-wreath, there is no available information on life-cycle stages, time from seedling to maturity or longevity of individual plants. It is suspected that Shasta snow-wreath has persisted on the current landscape in perhaps the approximate same distribution in which it now occurs for up to 34 million years based on the base geology and fossil record in Canada (DeVore et al. 2004, 2005, 2007, Ertter 1993, Stebbins 1993, Wehr and Hopkins 1994, Irwin 2003). This is also supported by the genetic studies presented in the following sections. Another ancient species, Quaking aspen, *Populus tremuloides*, which employs a clonal growth habit only produces seedlings after major disturbances in the western United States (Romme et al. 2005) and might provide a model for Shasta snow-wreath as might other shrubs that have seeds that germinate after fire (Keeley 1987).

Genetics

In 2009, tissue samples were collected from 21 of 24 known populations for isozyme analysis. This study assayed 17 isozyme loci to address 3 questions (DeWoody et al. 2012a).

1. How many genetic individuals compose each population?
2. How is genetic diversity distributed within and among populations?
3. Do patterns of genetic diversity or genetic similarity among populations correspond to geographic or ecological factors?

> When assessed at 17 loci, a total of 48 multilocus genotypes were identified in the collection of 410 samples, indicating Shasta snow-wreath is capable of significant vegetative reproduction. Five populations were composed of a single genet each, with an average of 3.14 genets per population and a maximum of 15 genets in a single population. Allelic diversity was low, with a maximum of 3 alleles observed at one locus. Populations were differentiated, with 85% of the allele frequency variance distributed among populations. Multivariate analysis identified 3 clusters of genetically similar populations: one cluster composed of 15 populations, a second cluster composed of 5 populations, and one population being distinct. Individuals from the distinct population displayed unique alleles at 2 loci (AAT-1 and AAT-2). The distribution of populations among clusters did not correspond to geographic (watershed) or substrate classifications, indicating that additional, unmeasured factors may influence the genetic structure of this species. Five populations were composed of a single genet each with an average or 3.14 genets per population and a maximum of 15 genets in a single population.

DeWoody et al. (2012a) indicate that:

> This survey of isozyme variation in the rare endemic *Neviusia cliftonii* revealed low levels of allelic and genotypic diversity. The lack of variation within many populations (only one or 2 genets identified in 57% of populations sampled) is consistent with regular vegetative reproduction of this woody species. The genet diversity is greater than that reported for the sole congener, *N. alabamensis*, which contained only one genotype per population at its marginal range (Freiley 1994). The low levels of allelic variation may be a consequence of the narrow range occupied by

> *N. cliftonii*, or it may be due to historic population bottlenecks. For instance, the Shasta Lake area is known as an ancient landscape, a glacial and volcanic refuge, with high numbers of endemic species (Lindstrand and Nelson 2006). The low allelic variation may be a consequence of the narrowing of the *N. cliftonii* range during the most recent glacial maximum and subsequent climate variations (Lindstrand and Nelson 2006). Alternatively, the low variation may reflect a more recent bottleneck resulting from Shasta Dam and Shasta Lake. Construction of the dam likely increased fragmentation and decreased the size of some populations, which together can change the genetic structure of populations (Honnay et al. 2007, Aguilar et al. 2008). The low levels of genotypic variation within populations prevented statistical analysis for genetic signatures of population bottlenecks (sensu Cornuet and Luikart 1996).

DeWoody et al. (2012a) also indicate that:

> One possible consequence of vegetative reproduction is a greater potential for populations to be genetically distinct, as vegetatively reproducing species tend to have poor dispersal capability (Ellstrand and Roose 1987, Silvertown 2008). Plants that have mechanisms for long-distance dispersal via either pollen or seed typically display lower levels of genetic differentiation between populations than those with limited dispersal (Hamrick and Godt 1996).

Pollination

Pollination is the primary step in seed formation. Shasta snow-wreath is currently known to clonally propagate but it does also rarely produce achenes (see earlier pictures, Puentes 2011, Doyen 2015, Shevock et al. 1992, Ertter and Shevock 1993), apparently from sexual reproduction but the seeds within are not confirmed to germinate in the wild or in attempts to propagate (personal communications Julie Kierstead Nelson 2016b, Ertter and Shevock 1993).

It is currently unknown as to whether the achenes/seeds are produced from selfing (fertilization by means of pollen from the same plant) or from cross pollination. Ertter and Shevock (1993) indicate that blossoms have no scent.

Knuth (1906) indicates that Alabama snow wreath (*Neviusia alabamensis*) and Japanese Kerria (*Kerria japonica*) are both self-sterile (the effect of pollen on the stigma of the same flower is inactive).

In the 26 years of observation by botanists, no recently germinated seedlings have been confirmed (Julie Kiersted Nelson personal communications 2016a, Ertter and Shevock 1993, Jules et al. 2017).

It is undetermined if pollination occurs via wind (anemophily) or by insects (entomophily). From the structure of the flowers, it would appear that Shasta snow-wreath might be wind pollinated.

Figure 5. Shasta snow-wreath flower structure

Source: Julie Kierstead Nelson 2016c.

However, from its location in the lower canopy, it would appear that insect pollination is more likely.

Figure 6. Shasta snow-wreath in the lower canopy.

Source: Julie Kierstead Nelson 2010a from CalPhotos.

There are no recorded observations of insects visiting blossoms of Shasta snow-wreath. Ertter and Shevock (1993) document a lack of scent from the blossoms. Ertter and Shevock (1993) also document the search for pollinators during the May 1993 surveys.

Japanese Kerria (*Kerria japonica)*, the only other species within the tribe Kerriaea with recorded information, is insect pollinated (Plants for a Future 2012). Knuth (1906) indicates that Alabama snow wreath (*Neviusia alabamensis*) and Japanese Kerria (*Kerria japonica)* are both self-sterile (the effect of pollen on the stigma of the same flower is inactive). Pendleton and Pendleton (1998) indicate that *Coleogyne ramosissima*, within the tribe Kerria is wind pollinated.

Because it is thought that Shasta snow-wreath is a relict species that may have originated during the Eocene tertiary geological period (56 to 33.9 million years ago) (Ertter 1993, Stebbins 1993),

there may be a pollinator that is extinct and has led to an extinction debt (the future extinction of species due to events in the past). There was significant mass extinction of insects, at the end-Permian (Permian–Triassic; P-T) (Labandeira 2005) which may have affected the available pollinators for Shasta snow-wreath.

Kuussaari et al. (2009) indicate that extinction debt is a phenomenon that can easily remain unnoticed but that should be taken into account in conservation planning. Habitat loss, climate change and invasive species are the main global threats to biodiversity constituting key single and synergistic drivers of extinctions. The effects of these components of global change can be almost immediate in some cases, but often it takes a considerable amount of time for declining populations to disappear following environmental perturbations: delayed extinctions, also called extinction debt, are an important factor to consider in biodiversity conservation. However, as long as a species that is predicted to become extinct still persists, there is time for conservation measures such as habitat restoration and landscape management.

Terminology associated with extinction events from Kuussaari et al. (2009) that helps to explain the concept is shown below.

> **Equilibrium state:** Also known as stable state. Situation in an ecological community when the number of species is not changing because the rate of local extinctions equals the rate of local colonizations.
>
> **Extinction:** The disappearance of a species. Extinction might occur locally (at the level of a habitat patch), regionally (at a landscape level) or on larger spatial scales (at country, continent or global levels).
>
> **Extinction debt:** In ecological communities, the number or proportion of extant specialist species of the focal habitat expected to eventually become extinct as the community reaches a new equilibrium after environmental disturbance such as habitat destruction, climate change or invasion of exotic species. In single species, the number or proportion of populations expected to eventually become extinct after habitat change.
>
> **Extinction threshold:** The minimum amount of habitat area, connectivity and quality required for a species to persist.

Focal habitat: The habitat type that is currently under observation. Focal patch is the particular habitat patch under observation.

Habitat connectivity: The amount of focal habitat in the landscape surrounding the focal habitat patch (opposite to isolation). Ideally measures of connectivity take into account both the area and distance of the surrounding patches.

Habitat loss: Decrease in area of the focal habitat, used here as a surrogate for habitat area loss and habitat fragmentation, i.e., covering a decrease in both area and connectivity of habitat patches.

Metapopulation: A set of local populations that occupy a network of habitat patches and are linked by dispersal.

Relaxation time: Also known as time lag to extinction, extinction lag, time delay to extinction, time to extinction. The time taken for a community of species to reach a new equilibrium after an environmental disturbance. Extinction debt is gradually paid during the relaxation time as the expected extinctions are realized.

Pollination biologists have shown that pollination failure can occur at all steps in the dispersal process and at several different levels. Increased risk of pollination failure is associated with pollen if it is delivered to a stigma too little, too much, too late, too mixed in composition or too poor in quality. It is associated with pollinators when they are too few or too inconstant, and with plants when they are too specialized or too selective. It is associated with populations when they are too sparse, too small in number or too uniform genetically, and with communities when they are too fragmented, genetically impoverished or under rapid modification. Understanding the causes of pollination failure in plants can aid the successful conservation and recovery of rare plants, maintenance of crop yields, and sustainable use of wild plant resources such as forest timber (Wilcock and Neiland. 2002).

Climate change could also affect pollinators and phenology (bloom timing) such that pollinators are not available during the short bloom season for Shasta snow-wreath (Yang and Rudolf 2010).

Habitat

Shasta snow-wreath grows in the dense understory of black oak (*Quercus kelloggii*), yellow pine (*Pinus ponderosa*) dominated mixed conifer forests and foothill pine (*Pinus sabiana*) blue oak (*Quercus douglasii*) habitat around Shasta Lake north of Redding, California (Shevock et al. 1992, Lindstrand and Nelson 2005a, 2006, Jules et al. 2017, CNDDB 2018, figure 6). Shasta snow-wreath occupies sites on lower slopes of steep mountain valleys on various aspects on non-wetland sites (Calflora 2019, NatureServe 2016). It occurs in riparian sites within the yellow pine forest community (Calflora 2019).

Table 2. List of Associated Species.

Scientific Name	*Common Name**	*CNDDB EO***	*Source*
Acer macrophyllum	bigleaf maple	1,2,3,5,6,7,12,16,18,19,24	1,2,3,5
Achillea millefolium	Yarrow	22	2
Adiantum sp.	Maidenhair fern	3	2
Adiantum aleuticum	Five finger maidenhair	14	2
Adiantum jordanii	California maidenhair fern	7	2,5
Aesculus californica	buckeye	5,18,21,23,26	1,2,3,4,5
Alnus rhombifolia	White alder	5	2,3
Aquilegia formosa	Columbine	14	2
Aralia californica	California spikenard		3,4
Arbutus menziesii	Madrono	1,19	1,2,4
Aristolochia californica	California pipevine	1,21	1,4,5
Aruncus dioicus var. pubescens	Bride's feathers		4
Asarum hartwegii	Hartweg's wild ginger	1,3	1,4,5
Berberis sp.	Oregon Grape	5	2,3
Berberis aquifolium var. dictyota	Jepson's Oregon Grape		1
Calocedrus decurrens	Incense cedar		4
Calycanthus sp.	Spicebush	1	2
Calycanthus occidentalis	Spicebush		1,3,4,5
Ceanothus sp.	Ceanothus	2	2
Ceanothus integerrimus	Deer brush	20	2
Cercis occidentalis	Western redbud	11,16,22	1,2,3,5
Cercocarpus betuloides	Birch leaf mountain mahogany		5
Clematis lasiantha	Pipestem		1
Cornus sp.	Dogwood		3
Cornus nuttallii	Mountain dogwood	5,6,8,11,12,19,24	2,4,5
Cornus sericea	American dogwood		1
Cornus sessilis	Western cornelian cherry	22	1,2,4,5
Corylus cornuta	Beaked hazelnut	7,11,25	2,3,5
Corylus cornuta var. californica	Beaked hazelnut	23	1,4
Cynoglossum grande	Houndstongue	22	2
Cytisus scoparius	Scotch broom	3	2

Scientific Name	Common Name*	CNDDB EO**	Source
Frangula californica	California coffeeberry		3
Fraxinus depetala	Two petaled ash		5
Fraxinus latifolia	Oregon ash		3,5
Holodiscus sp.	oceanspray	1	2
Holodiscus discolor	oceanspray		1
Ligusticum californicum	California lovage		1
Lithophragma bolanderi	Hillstar	7	2
Lonicera hispidula var. vacillans	Pink honeysuckle		1
Lonicera interrupta	Chaparral honeysuckle	20	2
Oemleria cerasiformis	Oso berry	26	2
Osmorhiza berteroi (chilensis)	Sweet cicely		5
Paxistima myrsinites	Oregon boxwood		1,4
Philadelphus sp.	Wild mock orange	21	2
Philadelphus lewisii subsp. californicus	Wild mock orange	3,18,22,24,25,26	1,2,3,4,5
Physocarpus sp.	Ninebark	1	2
Physocarpus capitatus	Ninebark	14	1,2,4
Pinus attenuata	Scrub pine		3
Pinus lambertiana	Sugar pine	8,16	2
Pinus ponderosa	Ponderosa pine	2,8,10,14,15,16,18,21,25,26	2,3,5
Pinus sabiniana	Bull pine	21,25,26	2,3,5
Polygala cornuta	Sierra milkwort		1
Prunus sp.	Plum	1	2
Prunus subcordata	Sierra plum		1,4
Pseudotsuga menziesii	Douglas-fir	5,6,7,8, 11,12,15,17,18,19,22,23,24	1,2,3,4,5
Quercus sp.	oak	1	2
Quercus chrysolepis	Gold cup live oak	10,11,12,15,16,20,21,23,24,25,26	1,3,5
Quercus douglasii	Blue oak	10	2
Quercus garryana var. breweri	Oregon oak	5,6, 10,15,18,21,23	1,2,3,5
Quercus kelloggii	California black oak	5,6,7,14,15,16,23,25,26	1,2,3,5
Quercus wislizenii	Interior live oak		1,3,5
Ribes sp.	Gooseberry	14	2,3
Rhamnus sp.			5
Rhus aromatica (trilobata)	Fragrant sumac		5
Rosa sp.	Rose	5	2,3,5
Rosa gymnocarpa	Wood rose		1
Rubus sp.	Blackberry	23	2,3
Rubus discolor (armeniacus)	Himalayan blackberry	3	2
Rubus ursinus	California blackberry	22	2,5
Salix sp.	Willow		3
Smilax californica	Greenbriar	7	1,2,4
Staphylea sp.	Bladdernut	5	2
Staphylea bolanderi	Bladdernut		3,4

Scientific Name	Common Name*	CNDDB EO**	Source
Styrax officinalis var. californica	California snowdrop bush	6,14	1,2,4,5
Styrax redivivus	California snowdrop bush	22	2,3,4
Symphoricarpos albus	Common snowberry		1,3,5
Symphoricarpos alba var. laevigatus	Common snowberry	7	2
Taxus brevifolia	California yew	19	2,5
Toxicodendron	Poison oak	1,2,5,6,21,24,26	2
Toxicodendron diversilobum	Poison oak	14,16,19,20	1,2,3,4,5
Trientalis latifolia (Lysimachia latifolia)	Pacific starflower		1
Trillium chloropetalum	Giant wakerobin		5
Umbellularia sp.	California bay	5,15,20,25	2,3,5
Vitis sp.	Wild grape	21	2
Vitis californica	California wild grape		1,5
Viola ocellata	Western heart's ease	7	2
Whipplea modesta	Modesty		1

1. Shevock et al. 1992
2. CNDDB 2018
3. Jules et al. 2017
4. Taylor 1993
5. Shevock et al. 2005

*Calflora

Shasta snow-wreath was originally thought to occur only on limestone but is now documented to occur on other substrates (Shevock et al. 2005, Lindstrand and Nelson 2005a, Lindstrand and Nelson 2006). Figure 2 (Google Earth Image 2019) illustrates the variety of substrates.

Figure 7. Neviusia cliftonii; (shown with Quercus kelloggii)

Source: Julie Kierstead Nelson 2010b.

Currently, Shasta snow-wreath is found in 24 locations that occupy about 116 acres (NatureServe 2016, CNDDB 2018) and that are spread across about 250 square miles. The occurrences are not directly connected by occupied or even suitable habitat. (NatureServe Explorer 2016, Lindstrand and Nelson 2005a, b, Lindstrand and Nelson 2006, DeWoody et al. 2012a, K.S. Roche observations 2016).

Shasta snow-wreath is presumed to have been more widespread and populations more connected along river corridors before the filling of Shasta Lake in 1948, as evidenced by the many populations that reach their lower limit at the full pool line of Shasta Lake (DeWoody et al. 2012a, Lindstrand and Nelson 2006).

Hanski and Ovaskainen (2001) indicate that to allow for long-term metapopulation persistence, a network of habitat fragments must satisfy a certain condition in terms of number, size, and spatial configuration of the fragments. The influence of landscape structure on the threshold condition can be measured by a quantity called metapopulation capacity, which can be calculated for real fragmented landscapes. Habitat loss and fragmentation reduce the metapopulation capacity of a landscape and make it less likely that the threshold condition can be met. If the condition is not met, the metapopulation is expected to go extinct, but it takes some time following habitat loss before the extinction will occur, which generates an extinction debt in a community of species.

Vellend et al. (2006) indicate that when habitats are fragmented, species are expected to go extinct from small isolated habitat patches, but this process of ‘‘relaxation’’ (Diamond 1972) takes time. Until relaxation is complete, such habitat patches are said to have an ‘‘extinction debt’’ (Tilman et al. 1994), in that some species are destined to go locally extinct even in the absence of further perturbations.

Climate

Sawyer (2006) indicates that the middle Sacramento River country of western Shasta County, where Shasta snow-wreath occurs, experiences hot summers and rainy winters. These lands do not lie in the rain shadow of the mountains to the west, since many winter storms move up the Sacramento Valley. Areas at higher elevations receive ample precipitation (60–100 in. annually), but the canyon lands receive only half that of the mountain slopes. Winter temperatures at lower elevations are mostly above freezing, and summer temperatures are very high. Only the highest peaks hold snow into the summer.

Newburn and Payne (2014) describe the climate for the Green-Horse project area that surrounds many of the occurrences of Shasta snow-wreath as: as Mediterranean, characterized by wet, cool winters and dry, warm summers. Mean annual precipitation varies from approximately 70 inches in the upper portions of the watersheds to nearly 40 inches at the lower end. About 90 percent of the precipitation falls between October and April, the majority of which occurs as rain with very little snowpack. Summer thunderstorms are common and can release significant localized rain.

These storms can also be dry with conditions that encourage fire ignition and spread from lightning strikes, with an event in June of 2008 being an example of this pattern (Bagley Fire).

Since the Shasta snow-wreath occurs in the vicinity of Shasta Lake, Shasta Dam is the closest and most pertinent quantitative weather and climate record. The temperature and precipitation at Shasta Dam from 1981 to 2010 is summarized in the table below.

Table 3. Temperature and Precipitation Data at Shasta Dam.

Measurement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	52.5	56.7	61.3	68.5	77.5	86.0	95.2	93.7	87.8	75.2	60.5	53.1	72.3
Average Min. Temperature (F)	38.9	41.0	43.0	47.7	54.8	62.2	68.3	66.6	62.3	54.4	45.6	40.1	52.1
Average Total Precipitation (in.)	11.12	10.05	8.74	4.37	2.58	1.30	0.20	0.40	1.05	3.40	7.86	10.74	61.82
Average Total Snow Fall (in.)	2.2	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	3.9
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Western Regional Climate Center 2016.

Because Shasta snow-wreath is considered a living fossil (Ertter 1993, Stebbins 1993), the paleo climate is also worth examining. Wolfe (1978) indicates that the Paleocene and Eocene floras from North America…provide the basis for a number of climatic inferences: (1) An overall gradual warming took place from the Paleocene into the middle Eocene, with gradual cooling until the terminal Eocene event and (2) Cool intervals occurred during the late Paleocene, the late early to early middle Eocene, and the early late Eocene. Thus, the changes in climate may have affected the current existence, distribution and survival of Shasta snow-wreath. The paleo climate was influenced by continental movements, changes in ocean circulation patterns, building mountain ranges, and the Laurentide ice sheet (Minnich 2007). At different times, the paleo climate was warmer and dryer as well as colder and wetter than the current (Topel et al. 2012) meaning that Shasta snow-wreath appears to have considerable plasticity or adaptability to different climate regimes.

Fire History

Newburn and Payne (2014) discuss the fire history of the Green-Horse project area, which overlaps the distribution of Shasta snow-wreath, in their 2014 report:

> …few forested regions have historically experienced fires as frequently and with such high variability in fire severity as the Klamath Mountains Bioregion (Taylor and Skinner 1998), this is primarily due to climatic variables and the diverse physical and biotic arrangement of the Klamath Mountains. South- and west-facing aspects and upper slope positions typically experienced higher severity fire than lower slopes and north- and east-facing aspects. On the eastern edge of the Klamath Mountains, median fire return intervals ranged from 8 to 38 years (Skinner et al. 2006). With frequent fire of low to mixed severity, fuel accumulations over most of the area were historically maintained at low levels, and landscape features such as ridge-tops and streams were often sufficient to impede fire spread (Skinner et al. 2006).

Newburn and Payne (2014) go on to indicate:

> …fire suppression efforts were institutionalized after the establishment of the National Forest System (circa 1876-1905). Since the onset of fire suppression in the early 1900s, and with the increased effectiveness of mechanized suppression techniques (fire engines, aircraft, etc.) in later years, most of the fires were kept small until recent years. [Supporting references added: Calkin et al. 2014, USDI et al. 2001, Williams 2005.]

The acres burned by wildfire within the Green-Horse project area since 1920 are shown in the following table.

Table 4. Acres burned by wildfire in the Green-Horse project area 1920-2016, by decade

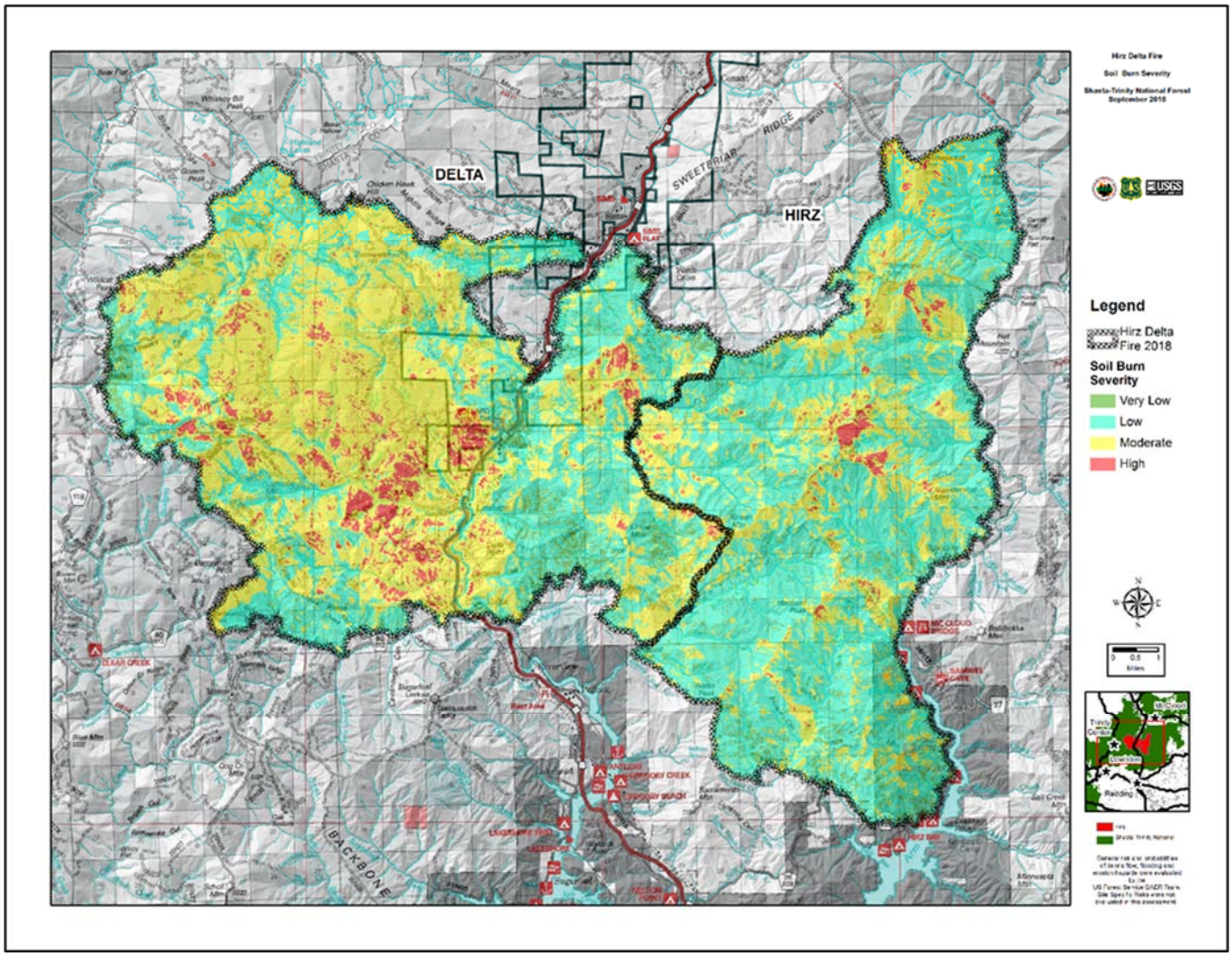
Decade	Acres Burned
1920s	7,592
1930s	20,239
1940s	247
1950s	0
1960s	0
1970s	0
1980s	0
1990s	0
2000s	51
2010s	5
Total	28,134

Source: Newburn and Payne 2014.

There were additional fires that occurred between 2016 and the present. Those have not been summarized here. There is a map of the Hirz fire of 2018 later in this document that provides a

visual comparison. The Mountain Fire (CalFire 2019) burned close to the Jones Valley habitat (Element Occurrence 16) in August 2019.

Figure 8 Hirz and Delta Fires Burn Perimeter and Final Burn Severity



Source: USDA FS STNF 2018a.

Geology and Soils

Kruckeberg (2002) indicates that plants are captive of their inanimate environments. All terrestrial higher plants are tethered to some kind of underpinning: soil rock water or other plants. In turn, the anchoring media are the products of physical and biological processes and materials. A major component of the origin and character is geological.

Shasta snow-wreath occurs within the Klamath Geomorphic province (USDI BOR Mid-Pacific Region 2014b) on Triassic age terrane (Cheng 1997, Ertter 1993).

Hotz (1971) indicates that:

> The eastern Klamath belt where Shasta snow-wreath grows includes rocks that range in age from Ordovician (?)[sic] to Jurassic. Rocks of Ordovician (?) [sic] and Silurian age form an elongate belt on the east side of the province south of Yreka. A large area occupied by strata ranging in age from Devonian to Jurassic lies in the southeastern part of the province north of Redding. Both areas include lithologies typical of a eugeosynclinal environment of deposition that is, graywacke, sandstone, shale and mudstone, chert and chert pebble conglomerate, impure limestone, and a wide variety of volcanic rocks including greenstone, pillow lavas, volcanic breccias and pyroclastics of basaltic composition, spilite and keratophyre flows and pyroclastics, and andesitic flows and tuffs. Strata of the eastern Klamath belt are estimated to have an aggregate thickness of 40,000-50,000 feet.

The Devil's Rock Hosselkus limestone is Triassic in origin (Keeler-Wolf and Keeler-Wolf 1975, Keeler-Wolf 1989, Cheng 1997).

Figure 9. Distribution of Shasta snow-wreath occurrences by geologic type.

Geologic map unit	Formation	Rock type	Age	No. Shasta snow-wreath occurences
Cb	Baird	Metasedimentary	Carboniferous	2
Cbmv	Baird	Metavolcanic	Carboniferous	1
Dc	Copley Greenstone	Metavolcanic	Devonian	1
Pmd	Quartz Diorite – Dikes	Intrusive	Permian	1
Pmml	McCloud Limestone	Carbonaceous	Permian	1
Pmn	Nosoni	Metasedimentary/ metavolcanic	Permian	1
Trh	Hosselkus Limestone	Carbonaceous	Triassic	4
Trm	Modin	Metavolcanic[1]	Triassic	3
Trp	Pit	Metasedimentary	Triassic	3

Source: Lindstrand and Nelson 2005a.
1–Also contains limestone fragments and strata.

Soils range from non-existent to thin and rocky to deep soils formed by erosion of steeper slopes (Personal observations, Google Earth image 2019, Figures 2 and 8).

Figure 10. Distribution of Shasta snow-wreath occurrences by order 3 soil type.

Order 3 soil map unit	Dominant soil type	Dominant parent material	No. Shasta snow-wreath occurrences
102	Holland Family	Metasedimentary/metavolcanic	1
105	Holland Family	Metasedimentary/metavolcanic	5
117	Holland Family, deep	Metasedimentary/metavolcanic	1
178	Marpa Family	Metasedimentary/metavolcanic	1
179	Marpa Family	Metasedimentary/metavolcanic	1
180	Marpa Family	Metasedimentary/metavolcanic	1
183	Marpa Family	Metasedimentary/metavolcanic	1
195	Millsholm Family	Sedimentary	1
204	Neuns Family	Metasedimentary/metavolcanic	1
222	Neuns Family	Metasedimentary/metavolcanic	1
250	Rock Outcrop, limestone	Limestone	3

Source: Lindstrand and Nelson 2005a.

THREATS

The threats to Shasta snow-wreath are both anthropogenic and natural and are presented below in term of the factors required under the CESA.

Factor A. Modification or curtailment of habitat or range

The Shasta snow-wreath is endangered with significant destruction, modification, and curtailment of habitat and range, as a result of a number of actions which are discussed in more detail in the following paragraphs.

Inundation

Shasta snow-wreath occurrences and potential habitat is threatened by the BOR (Federal) Action proposed to raise Shasta Dam. Shasta Lake (Reservoir) currently stores 4.55 million acre-feet (MAF) of water and covers an area of about 29,500 acres with a shoreline of about 420 miles. The proposal, if implemented, at the highest raise level would inundate additional area up to about 32,300 acres of land surrounding the existing Shasta lake (reservoir) (USDI BOR 2015). Inundation would destroy known occurrences and potential habitat as well as change hydrology and drainage of habitat areas.

The BOR in its 2013 Draft Fish and Wildlife Coordination Act Report (USDI BOR 2013) indicates that at that date:

During botany surveys and vegetation and habitat mapping surveys (NSR 2004, Lindstrand and Nelson 2005a,b, Lindstrand 2007), Shasta snow-wreath was found at nine sites within the Inundation Zone of the SLWRI. Therefore, 43 percent (9 of 21 subpopulations) of the entire known population of Shasta snow-wreath could be lost (or partly lost) by the proposed raising of Shasta Dam; other subpopulations could potentially be disturbed by the relocation of roads, bridges, campgrounds, and other facilities due to the SLWRI (Lindstrand 2007). The subpopulations found within the Inundation Zone include: (1) a single, relatively large population occurring in riparian habitat along the Ripgut Creek riverine reach (Pit River Arm); (2) a large, previously known population along Campbell Creek (McCloud River Arm); (3) a very large population in riparian habitat along both sides of Stein Creek (Pit River Arm) extending from near the Stein Creek/Shasta Lake confluence to 0.25 mile upstream; (4) a small population found at an unnamed stream south of Cove Creek in riparian and mixed woodland habitat on the right bank, at the confluence with Shasta Lake; (5 and 6) one moderate and one large population along Blue Ridge on the main body of Shasta Lake in hardwood-conifer and ponderosa pine habitats immediately above the Shasta Lake high water line; and (7) a moderate-sized population in riparian habitat along both banks of Keluche Creek (McCloud River Arm) near the Keluche Creek/Shasta Lake confluence (NSR 2004, Lindstrand 2007).

Other disturbances associated with Dam raise

Other disturbances could occur from moving facilities or changing access and associated road construction (USDI BOR 2015). USDI BOR (2013) goes on to say that in addition to the nine subpopulations of Shasta snow-wreath within the Inundation Zone, another eight subpopulations of Shasta snow-wreath are potentially threatened by non-project related activities (e.g., mining, development, fire, invasive species, and other human-related disturbances) due to their location adjacent to State highways, county roads, forest roads, trails, homes, and transmission lines (Lindstrand 2007). Therefore, only 19 percent of all the known populations of Shasta snow-wreath (4 out of 21 subpopulations) are not currently threatened by SLWRI or non-project related activities (Lindstrand 2007). (See computations based on current EO numbers below).

From USDI BOR (2013):

> …the [FWS] Service believes that the SLWRI could result in adverse affects to rare and special status species in the vicinity of Shasta Lake, riparian habitat along the Sacramento River, and aquatic habitat in the Delta. It is unknown at this time if raising Shasta Lake would inundate a significant portion of the limited habitat of the following seven rare, but not federally listed, species each of which is endemic to the vicinity of Shasta Lake: Shasta snow-wreath (*Neviusia cliftonii*), Shasta salamander (*Hydromantes shastae*), Shasta sideband snail (*Monadenia troglodytes troglodytes*), Wintu sideband snail (*Monadenia troglodytes wintu*), Shasta chaparral snail (*Trilobopsis roperi*), Shasta hesperian snail (*Vespericola shasta*), and a rare undescribed variety of red huckleberry (*Vaccinium parviflorum –aka shastense*) but with blue berries unofficially known as "Shasta huckleberry" (Nelson and Lindstrand 2015, Lindstrand and Nelson 2005a,b; NSR 2004; Lindstrand 2007; DeWoody and Hipkins 2007 [DeWoody et al. 2012b]; Nelson, personal communications 2007). Additional habitat would be disturbed by construction-related activities and the relocation of campgrounds, roads, bridges, and other facilities above the Inundation Zone. The raising of Shasta Dam and implementation of the SLWRI would result in the loss, degradation, and fragmentation of habitat and may result in the need to further evaluate the factors threatening some of these seven species pursuant to section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA).

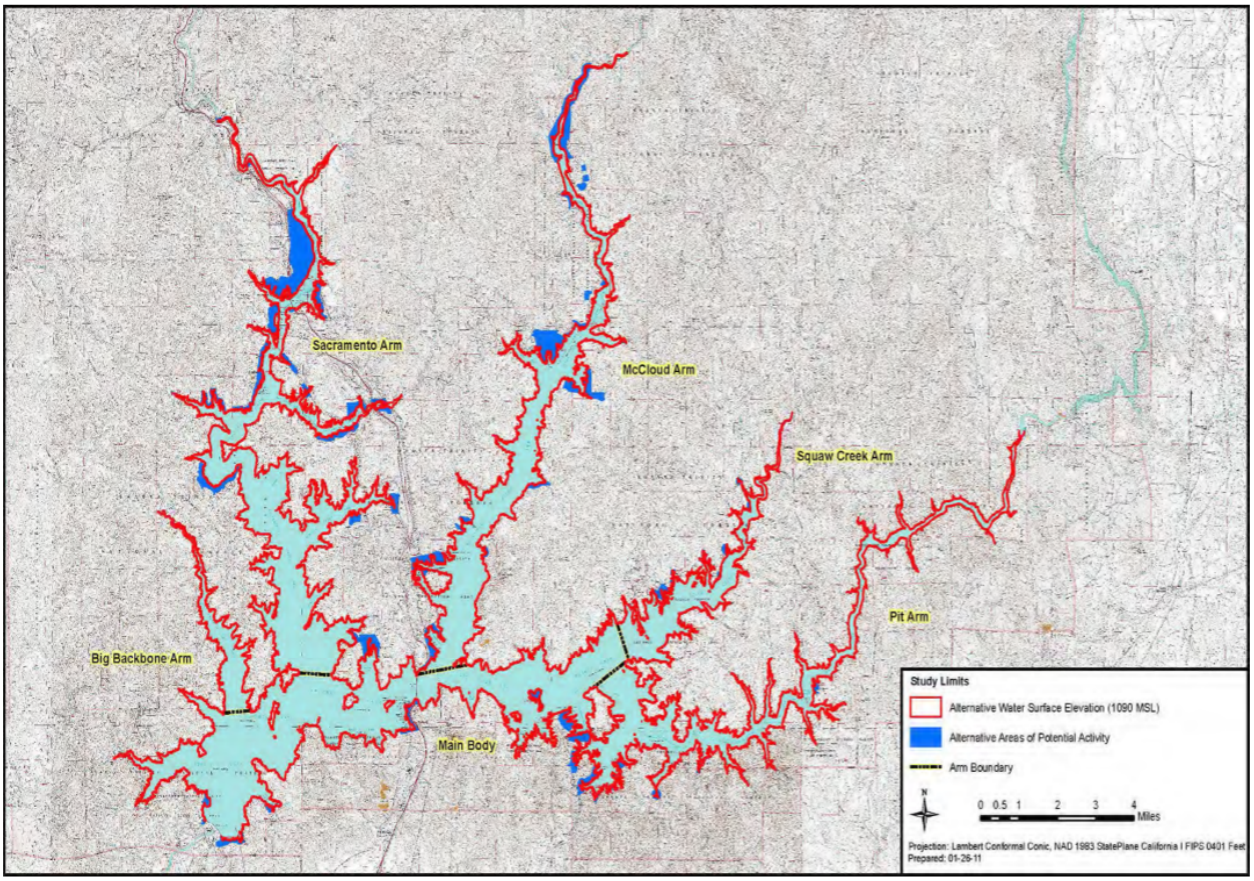
Comprehensive effects analysis is not available, but partial information indicates the following: Shasta snow-wreath, in particular, could be adversely affected USDI BOR (2013).

Since additional occurrences of Shasta snow-wreath have been documented since 2007 (now 24 element occurrences as compared to 21 in 2007, Lindstand 2007), **62 percent** of all known occurrences of the plant species (9 out of 24 occurrences by inundation plus 8 by other actions). Nine occurrences will be partly or completely inundated or affected by activities associated with raising Shasta Dam (Lindstrand and Nelson 2005a,b; Lindstrand 2007; CDFG 2007a). The CALFED Final Programmatic Environmental Impact Statement/ Environmental Impact Review (EIS/EIR) includes Shasta snow-wreath among "evaluated species for which direct mortality as a

result of implementing CALFED actions is prohibited as a condition of the Multi-Species Conservation Strategy" (CALFED Bay Delta Program 2000a,b, US GPO 2004).

Figure 11, illustrates the areas of potential affects from the dam raise, both inundation and associated actions.

Figure 11. USDI BOR Shasta Lake and Vicinity Portion of the Primary Study Area for Enlargement.



Source –USDI BOR 2014b.

Other Land Management Actions

Other actions that may affect habitat will occur as part of the on-going management of National Forest System (NFS) Lands for fire resilience. Eight occurrences of Shasta snow-wreath (33% of 24 total) are documented within the Green-Horse project area.

The Green-Horse Project Record of Decision (Myers 2016) indicates that:

- Prescribed broadcast burning or underburning would occur on approximately 41,6251 acres.
- Hand thinning and pruning of small trees and brush, followed by hand piling and pile burning or underburning, would occur on approximately 88 acres adjacent to private property.
- Hand thinning and pruning of small trees and brush, followed by hand piling and pile burning, would occur on approximately 35 acres surrounding recreation residences at Campbell Creek.
- Hand thinning and pruning of small trees and brush, followed by hand piling and pile burning or underburning, would occur on approximately 83 acres surrounding bald eagle nest sites.
- Approximately 4.61 miles (4 acres) of dozer line would be constructed or reconstructed in order to assist fire managers in safely conducting prescribed fire.

Fuels treatments would occur over a period of 7 to 10 years using a resource treatment strategy that would allow managers to adjust treatments over time if they discover new information or changed conditions. The proposed action does not include any commercial timber harvest, new forest system road or temporary road construction, existing road reconstruction or project-related road maintenance.

Under the selected alternative, a low-intensity surface fire (31 percent predicted for the project area) would damage some above-ground portions of individual plants, while underground portions would be unaffected, and plants would recover in the short term. A low-intensity surface fire within riparian/mesic habitats would likely benefit *Neviusia cliftonii* populations indirectly by reducing riparian vegetation cover and competition for understory resources (moisture, substrate, soil minerals, understory light), resulting in increased viability of these populations, until riparian vegetation recovers.

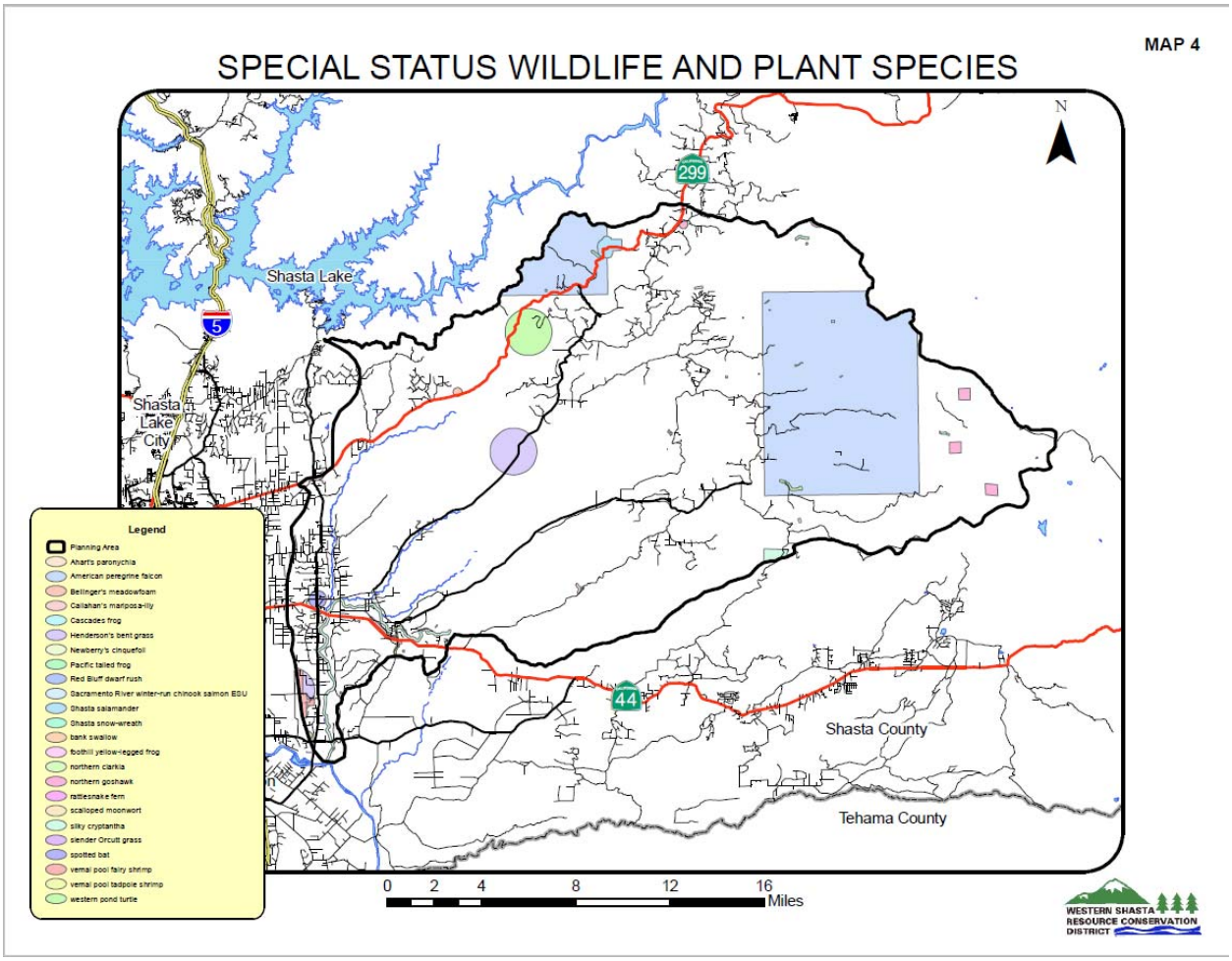
Riparian or generally mesic-associated species such as *Neviusia cliftonii* may also be affected by a loss of suitable habitat in the event of a high-intensity wildfire; however, since these species typically (although not exclusively) grow in moist environments where fire is less able to proliferate, negative impacts from these fire events may be more minor to moderate and shorter-term. If there were severe changes to the hydrologic regime from a high-intensity fire, though, negative impacts to these species would be major and longer-term.

In a high-intensity surface fire (0.03 percent predicted for the project area) –soil cover (e.g., woody debris, litter, duff) could be reduced which would also adversely impact the structural

stability of many plant species. Nutrients stored in the organic layer (such as potassium and nitrogen) vital for plant growth can also be lost or reduced in a high-intensity surface fire.

The Western Shasta Resource Conservation District under the Cow Creek Strategic Fuels Reduction Plan Update 2010 (WSRCD 2010) proposed fuelbreaks that may overlap the distribution of Shasta snow-wreath and may reduce the spread of wildfire in the area and into the area, once completed and if maintained (Figure 12).

Figure 12. Cow Creek Strategic Fuels Reduction Plan Map 4 of Special Status Wildlife and Plant Species.



Source: Western Shasta Resource Conservation District 2010.

Further, on-going vegetation encroachment including invasive species and forest trees threatens the destruction of habitat for Shasta snow-wreath.

USDI BOR (2013) indicates that Shasta snow-wreath is a slow growing species with a tendency to occur in relatively disturbed areas along the edge of the forest thus making the species especially vulnerable to invasive species (i.e., blackberry) and human-related threats (personal communications Julie Keirsted Nelson 2007).

Packers Bay invasive species project decision notice (Kennedy 2018) says:

> The selected alternative would allow us to treat non-native invasive broom [Scotch broom (*Cytisus scoparius*), French broom (*Genista monspessulana*), and Spanish broom (*Spartium junceum*)] infestations, reduce or eliminate the seed bank, and re-establish native vegetation on approximately 112 acres of National Forest System lands. Treatments will include: 1) using chainsaws and hand tools to cut the broom near ground level; 2) cut vegetation will either be piled and burned, or hauled away for disposal in a landfill; 3) using hand-held herbicide applicator wands and/or hand-held spray bottles to apply the herbicide combined with a surfactant and a colorant (dye) to the freshly cut broom stumps; 4) follow-up treatments including herbicide application, hand pulling, and prescribed underburning within treated areas to kill broom seedlings and seed bank; and 5) re-vegetating treatment areas with native plants where needed to lower the potential for re-invasion of invasive plants. Two herbicides, aminopyralid and glyphosate, will be used initially and a selection process initiated to determine the most effective for cut stump treatment. Both are known to be effective on broom. This decision also includes implementing the design features, best management practices, and monitoring to protect natural resources which are described in section 4 of the Environmental Assessment (EA).
>
> The modifications to Alternative 1 that the deciding official authorized are: Approximately 2 acres in the project area will be set aside for manual treatments without herbicides for a period of up to 10 years. Volunteers organized by the Environmental Protection Information Center (EPIC) will perform the treatments on a recurrent basis.

EPIC (2019) documents the manual treatments accomplished in 2019.

Forest Service road and trail maintenance could also threaten Shasta snow-wreath. Several populations occur immediately adjacent to roads and several populations occur immediately adjacent to trails.

Mining and logging particularly on private lands could threaten the existence of several occurrences (table 1). There are 6 of 24 (25% of total) occurrences on non-federal lands. These actions are regulated by the State of California and Shasta County. Since there is little or no requirement to protect Shasta snow-wreath, any ground disturbing actions on private land within occurrences or adjacent to occurrences could threaten individual clones and the habitat for Shasta snow-wreath.

Along with mining and logging on non-federal lands, other development within or adjacent to occurrences on private lands such as roads, houses or other structures could destroy habitat and result in the introduction of invasive species.

Invasive Species

In addition to the Packers Bay Invasive species project discussed above (Kennedy 2018, USDA FS STNF 2018), Jules et al. (2017) and CNDDB (2018a,b) document the presence of Himalayan blackberry (*Rubus armeniacus*) which can increase rapidly and have severe effects on plant communities (CAL IPC 2004).

Wildfires

Wildfires may threaten or benefit the occurrences of Shasta snow-wreath. The Hirz Fire of 2018, removed above ground portions of clones which resulted in respouting. Jules et al. (2017) includes observations of a prescribed burn in Jones Valley in December 2011. Jules et al (2017) also note that:

> The California black oak woodlands and Pacific ponderosa pine – Douglas-fir forests (Eyre 1980) 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 relatively fire-intolerant Douglas-fir in the overstory is indicative of prolonged fire suppression. Historically, this vegetation experienced frequent wildfires with an average fire return interval of

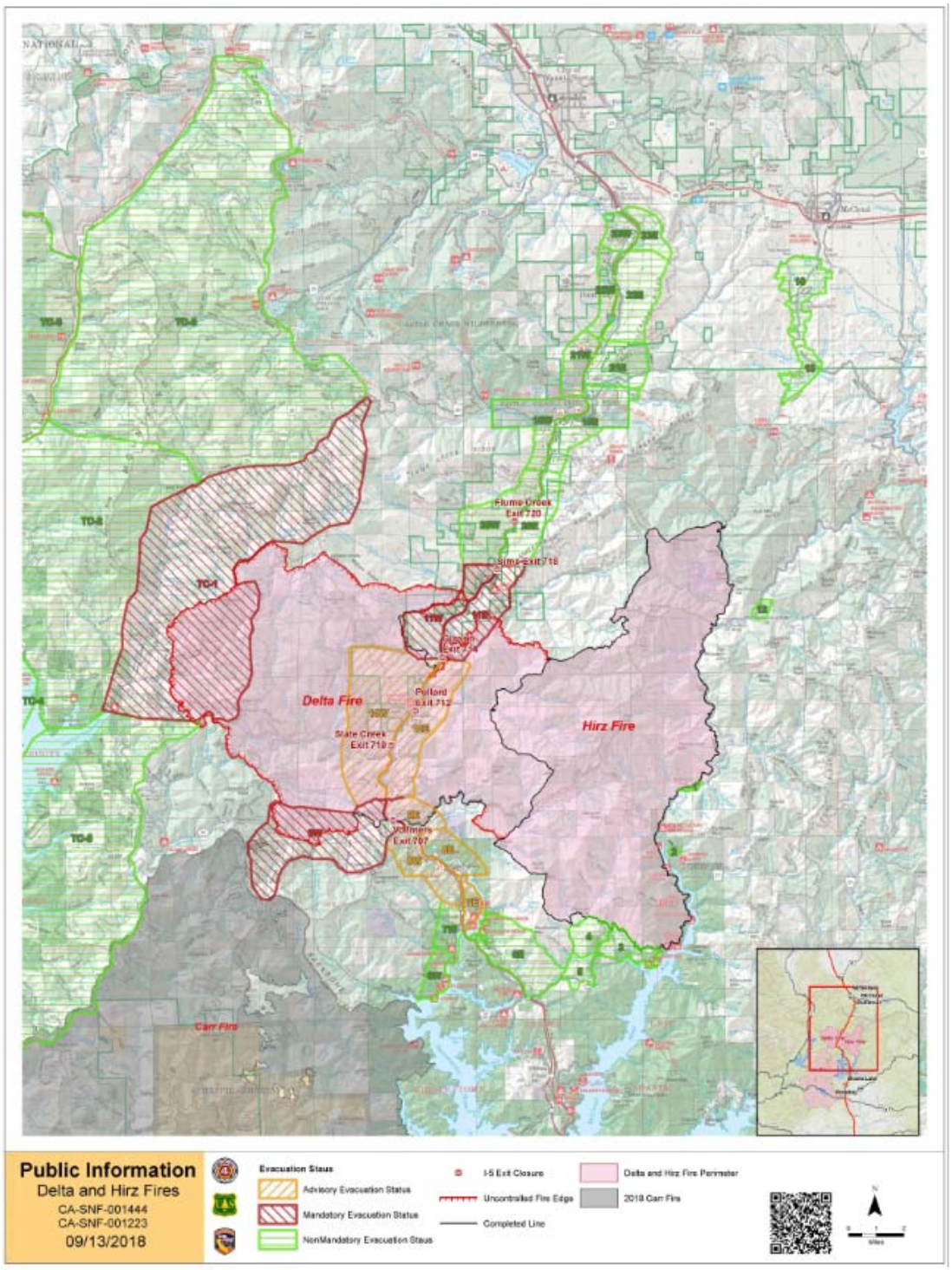
12 years (Taylor and Skinner 2003; Fry and Stephens 2006; Safford and Van de Water 2014). Restoring a more frequent fire return interval through prescribed burning or employing a mechanical fuels treatment to reduce canopy cover may benefit Shasta snow-wreath.

Repeat, short-interval fires may push ecosystems into new states, and recently there has been much discussion about disturbance regime thresholds beyond which ecosystem characteristics change dramatically due to a loss of resilience of the vegetation (Meng et al. 2014).

Wildfires can also facilitate the reproduction and/or representation of invasive species (Lambert 2010).

There is no specific information available about fire regimes in the paleo environment, however Byrne et al. (1991) indicate shifts between oak and pine as the dominant vegetation in much of northern California throughout the Holocene. These vegetation types are known to be susceptible to fire (Safford and Van de Water 2014).

Figure 13. Map of the Hirz and Delta Fires 2018.



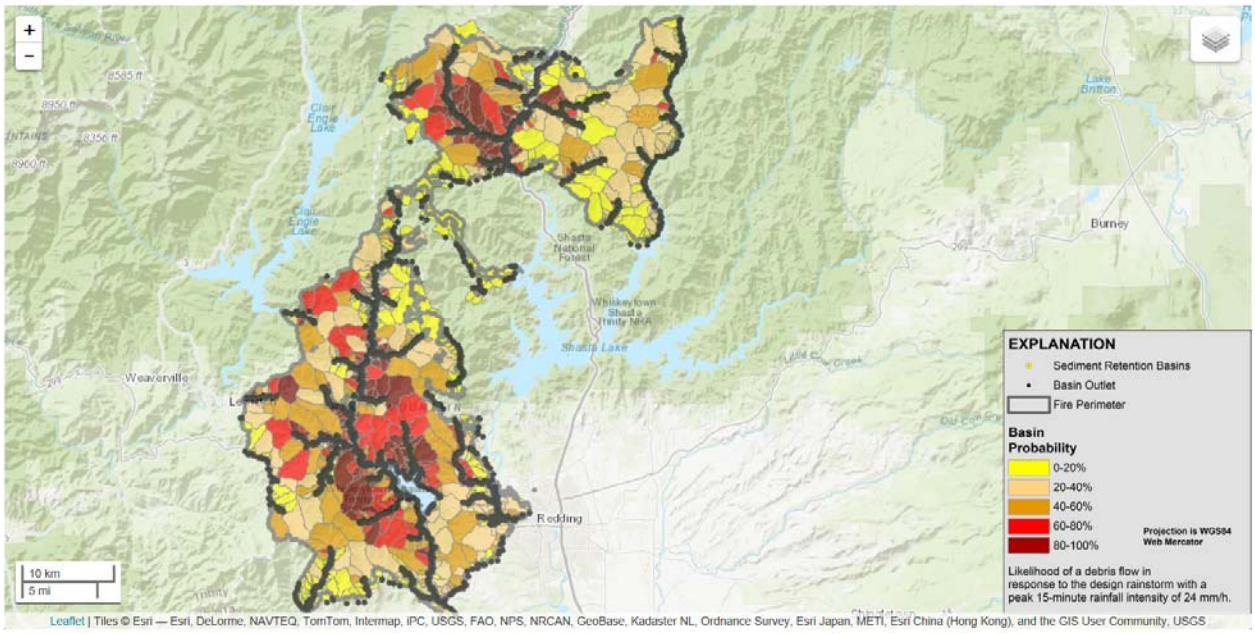
Source: NWCG Inciweb 2018.

Other Habitat Factors

Unstable Soils and Landslides

Shasta snow-wreath occurs in an area known to have unstable soils and landslides. That coupled with the its occurrence in a zone of known extreme fire and precipitation events, could result in reductions in occurrences and habitat. Jules et al. (2017) documented soil slumping from prescribed fire in December of 2011. Figure 13 illustrates the risk of debris flows after recent fires.

Figure 14. Map of the Hirz and Delta Fires 2018 with likelihood of debris flow.



Source: USDI USGS Landslide Hazards Program 2018.

Climate Change

Climate change could influence the continued existence of Shasta snow-wreath (Young et al. 2012, Pacifici 2015). It is unknown how much resilience Shasta snow-wreath has to changes in temperature or moisture regimes and how those changes might influence other destructive forces such as fire and/or landslides.

Through legislation and Governor's Executive Orders, the State of California has mobilized to meet the challenges and opportunities posed by climate change. The overall strategy is embodied in reducing carbon emissions, promoting readiness for climate impacts, preserving biodiversity,

and conducting research to provide the best available science to guide our actions. In the course of this work, technical documents, strategies, and planning guidance have been produced by state agencies, including the California Department of Public Health (CDPH). The Climate Change and Health Profile Report (Maizlish 2017) seeks to provide a county-level summary of information on current and projected risks from climate change and potential health impacts. This report represents a synthesis of information on climate change and health for California communities based on recently published reports of state agencies and other public data.

Table 5. Summary of Cal-Adapt Climate Projections for the North Region.

	RANGES
Temperature Change 1990-2100	January average temperature increase of 0.5°F to 4°F by 2050 and 3°F to 6°F by 2100. July average temperature increase of 3°F to 5.5°F by 2050 and 8°F to 10°F by 2100, with larger temperature increases in the mountainous areas in the northeastern portion of the region. *(Modeled high temperatures – average of all models; high carbon emissions scenario)*
Precipitation	Annual precipitation is projected to decline by approximately an inch by 2050 and 2 inches by 2100 for most of the region. *(CCSM3 climate model; high carbon emissions scenario)*
Heat Wave	Heat wave is defined as five days above a temperature between 89°F and 99°F depending on location. By 2050 there is projected to be two to four more heat waves than 2010. Projected heat wave occurrence in 2100 is variable depending on location, between six and 15 per year.
Snowpack	March snowpack disappears by 2090 for most of the region with the exception of areas near Mt. Shasta. *(CCSM3 climate model; high emissions scenario)*
Wildfire Risk	Substantial increases in the likelihood of wildfires are projected in most of the region, especially in Shasta and Siskiyou counties where risks may be multiplied 6 to 14 times by the end of the century. *(GFDL model, high carbon emissions scenario)*

Source: Maizlish et al. 2017.

At different times, the paleo climate that Shasta snow-wreath has endured, was warmer and dryer as well as colder and wetter than the current (Töpel et al. 2012) meaning that Shasta snow-wreath appears to have considerable plasticity or adaptability to different climate regimes. However, the ability of Shasta snow-wreath to migrate to find suitable climate niches is limited due to the steep terrain and human introduced impediments.

Destruction, modification, and curtailment of the habitat for Shasta snow-wreath from human activities is an ongoing threat to its continued existence.

Factor B. Overutilization

Overutilization for commercial, recreational, scientific, or educational purposes is currently occurring and may increase in the future if the SLWRI project is implemented and brings additional human presence to the area.

Shasta snow-wreath has been, and likely continues to be collected by botanists and gardeners for growing in personal gardens (reduced to possession—removed from federal ownership and committed to private ownership/possession) and for deposit as pressed and dried herbarium specimens.

The California Native Plant Society, CNPS Calscape (2019) and Calflora (2019) indicate the species is occasionally available from nurseries commercially.

Factor C. Disease and predation

Disease and Predation could be possible threats to Shasta snow-wreath. There are no documented diseases of Shasta snow-wreath at present. Personal observations by Julie Kiersted Nelson (2016c) at Low Pass indicate that some leaves appear to be colonized by fungi.

Figure 15. Shasta snow-wreath (Neviusia cliftonii) with fungal spots, growing with Himalayan blackberry at Low Pass. October 2011.

Source: Julie Kierstead Nelson 2011.

Since this plant has been known to science for only a short time, the absence of evidence of disease cannot be construed as the absence of diseases. It is expected that Shasta snow-wreath would be subject to the same diseases of other similar shrubs (Oceanspray or Ninebark) such as powdery mildew (UC IPM 2018), sudden oak death (*Phytophora ramorum*) or water mold (*Phytophthora spp.*) (Perry 2006**)** but so far there are no observations of these diseases. On-going monitoring could identify diseases present.

Climate change could make diseases more prevalent or make Shasta snow-wreath more susceptible to disease through stress (Elad and Pertot 2014). There is no information as to its susceptibility to other diseases such as water mold disease (*Phytophthora spp.*) or sudden oak death (*Phytopthora ramorum*). Other species within the rose family (Rosaceae) are known hosts, so it is possible that Shasta snow-wreath could be susceptible (USDA APHIS 2013).

There are also no observations of grazing damage from wildlife or cows/sheep. There are no active grazing allotments on NFS lands where Shasta snow-wreath occurs (USDA FS STNF 1996). Most of federal land on which Shasta snow-wreath occurs was acquired as part of the construction and flooding of Shasta Dam and Shasta Lake (reservoir) and as such never had federal grazing permits established. It is unknown if there are grazing permits on private lands where Shasta snow-wreath occurs.

Factor D. Existing regulatory mechanisms

The inadequacy of Existing Regulatory Mechanisms is also contributing to the threats to Shasta snow-wreath. Eighteen out of 24 (75%) occurrences are documented to be partially or completely on federal lands, either NFS or BLM administered public lands (See table 1 for details).

Shasta snow-wreath is included on the California Department of Fish and Wildlife Special Vascular Plants, Bryophytes, and Lichens List (CDFW CNDDB 2018a) but has no state-listing status under the California Endangered Species Act (CANRA DFW Biogeographic Data Branch CNDDB 2018b). This state listing would apply to occurrences on private lands and is considered in land management and project planning on federal lands. A state listing would be considered in the evaluation of species of conservation concern as the Shasta Trinity National Forest Land and Resource Management Plan is revised and in project planning.

Shasta snow-wreath is currently listed as sensitive by the USDA FS, Pacific Southwest Region (R5) under the Regional Forester's Sensitive Species list (USDA FS R5 2013) and by the USDI BLM (2015) for California. Sensitive species are managed to avoid a trend towards federal listing and consist of those species the Forest Service has identified as having a viability concern based on a significant current or predicted downward trend in population numbers or density and/or a significant current or predicted downward trend in habitat capability that would reduce a species' existing distribution.

As Forest Plans are updated to the 2012 Planning Rule standards (USDA FS 2012), the Shasta-Trinity National Forest (STNF) may, or may not, include Shasta snow-wreath in its "species of

conservation concern (SCC)" list. Once this occurs management on the forest would then no longer be subject to the Regional Forester's Sensitive Species list (USDA FS R5 2013).

The SCC list will at least partially use NatureServe Rankings. The Shasta snow-wreath is listed by NatureServe (NatureServe Explorer 2019) as:

- G2 - Imperiled (Global).
- N2- Imperiled (National).
- State of CA S2 – Imperiled (State Level).

Shasta snow-wreath occurs within the Devil's Rock-Hosselkus Research Natural Area (DRH-RNA) as currently established. Established Research Natural Areas are managed for natural conditions (Cheng 1997, USDA FS 2005). This status as an RNA could be considered for revision with the revision of the Shasta-Trinity National Forest Land and Resource Management Plan or under a separate process (USDA FS 2012).

Existing regulatory mechanisms appear to be inadequate to protect the species.

Factor E. Other factors

There are other Natural or Manmade Factors that continue to contribute to the threats to Shasta snow-wreath.

Pollination and Reproduction Challenges

Shasta snow-wreath is currently unknown to have any successful pollinators. It is undetermined if pollination occurs via wind (anemophily) or by insects (entomophily). Although there are pictures of achenes the viability of the seeds within is unknown and no seedlings have been observed. Germination attempts failed (Ertter and Shevock 1993). Only 48 genotypes have been identified.

Shasta snow-wreath occurs in an area known to have unstable soils and frequent landslides. That coupled with the its occurrence in a zone of known extreme precipitation events, could result in reductions in occurrences and habitat and influence the success of flowering and sexual reproduction if it occurs at all. Wildfires are other events that could drastically modify occurrences, habitat and pollinators. Extreme wildfire events are expected to increase under changing climatic conditions. Other weather conditions such as early or late frost could also

influence the function of flowers and insects if those are involved in reproduction at any time and thus influence reproductive success and genetic diversity.

Some of the Shasta snow-wreath material that has been removed from the wild might also provide for off-site conservation. The Dunsmuir Botanical Gardens in Dunsmuir, California has at least 2 specimens growing there. Located in the Dunsmuir City Park in far northern California, the Gardens encompass ten acres of hilly, wooded area with a meadow containing the various gardens. The purpose of the Dunsmuir Botanical Gardens is to enhance the natural setting of the Dunsmuir City Park for the enjoyment and horticultural education of the public through the establishment and maintenance of native and woodland plants (Dunsmuir Botanical Gardens 2014). Ertter and Shevock (1993) indicate that Members of the California Native Plant Society currently are cultivating *N. cliftonii* and that it is growing at East Bay Regional Parks Botanical Garden. Christman (2011) also documents off-site locations, while Breen (2019) and Tu (2019) document Shasta snow-wreath growing at the Hoyt Arboretum in Portland, Oregon since 1999. The California Native Plant Society (CNPS Calscape (2019) and Calflora (2019) indicate the species is occasionally available from nurseries commercially.

None of the Shasta snow-wreath is currently designated as a scientifically documented genetic resource of conservation value. There is no available documentation as to source or genetics of the cultivated plants.

No viable seeds of Shasta snow-wreath have been observed and no seedlings had been observed in over 20 years of informal monitoring. Seed collected in 1992, did not germinate under any of the tested regimes at the University of California Botanical Garden. There are no other reports of seed collected or of reproduction or viability testing. Achenes are known from photographs and from the type description.

Because Shasta snow-wreath occurs on an ancient landform and within topographic constrictions of that landform, it is likely unable to expand its range in response to changing circumstances including climate.

SUMMARY AND JUSTIFICATION

The Shasta snow-wreath is primarily endangered by significant destruction, modification, and curtailment of habitat and range through proposed and on-going projects but primarily by the proposed raising of the height of Shasta dam and the inundation of habitat. The SLWRI project would affect **62 percent** of all known occurrences of the plant species (9 out of 24 occurrences by inundation plus 8 by other actions) of the entire known population of Shasta snow-wreath.

Other proposed or on-going projects to manage vegetation may have both positive and negative effects on this species. Invasive plant species that can change and/or dominate Shasta snow-wreath habitat are documented within and surrounding known occurrences.

Overutilization appears to be a minor factor as do disease and predation. Other natural and man-made factors also appear to be a minor influence at this time although climate change and geological instability as affected by expected changes in climate and wildfires are difficult to quantify at this time.

The existing regulations are inadequate to reduce or prevent the proposed and on-going destruction of individuals and habitat and are not responsive to other factors that when added to the changes in habitat and occurrences are likely to lead to endangerment and or complete loss of this species.

URGENT RECOVERY ACTIONS NEEDED

Priority Category 1: Tasks needed to avoid imminent species extinction

Restriction of destruction/removal of occurrences, removal of above ground and below ground plant parts and modification of habitat for Shasta snow-wreath associated with the proposal to raise Shasta Dam such that occurrences and habitat would not be inundated or destroyed.

Priority Category 2: Tasks needed to maintain a viable population

The following list indicates priority category 2 tasks needed to maintain a viable population.

- Reduction in harmful disturbances to Shasta snow-wreath plants, plant parts and habitat that is occurring and planned to occur on federal lands. This reduction would occur as a

result of listing and consultation with USFWS and or CDFG/CDFW. Also, studies in what type and amount of disturbance might be beneficial.

- Habitat modeling through geographic information systems and field checking to determine if there are other occurrences and to ascertain best places for re-introduction. USDA-FS has the data and expertise to complete this. Alternately, this could be accomplished by independent contractors or University researchers.
- Collection and propagation of ramets/genets to conserve diversity in potential habitat and at an off-site location using best available science and plant propagation practices (Maschinski and Albrecht 2017). This would need to be funded and accomplished by independent researchers with CDFG/CDFW, USDA-FS and USFWS cooperation and coordination after listing.
- Studies in reproduction and pollination using best available science and methodology including studies of seeds and viability. This would need to be funded and accomplished by independent researchers with CDFG/CDFW, USDA-FS and USFWS cooperation and coordination after listing.
- Organized search for seedlings through-out its distribution. This would need to be funded and accomplished by independent researchers with CDFG/CDFW, USDA-FS and USFWS cooperation and coordination after listing.
- Ongoing control of invasive species and studies of effectiveness of control. This would need to be funded and accomplished by CFGC/CDFW, USDA-FS with USFWS cooperation and coordination after listing.
- Development of State level conservation agreements with non-federal landowners. This would need to be funded and accomplished by CFGC/CDFW, USFWS cooperation and coordination after listing.
- Support of actions to reduce climate change (Committee on Stabilization Targets for Atmospheric Greenhouse Gas Concentrations 2011). This would need to be funded and accomplished by the State of California, USDA-FS with USFWS cooperation and coordination after listing.
- Identification of fungal diseases currently affecting this species and determination of potential for spread and potential control. This would need to be funded and

accomplished by independent researchers with CFGC/CDFW, USDA-FS and USFWS cooperation and coordination after listing.

Request for Critical Habitat Designation Under Federal ESA

Under the California Endangered Species Act, there is no critical habitat designation process. This petition information is being concurrently submitted to the USFWS as well as the CFGC (Roche 2019b). There is a request to the USFWS to designate critical habitat under the Federal Endangered Species Act included in the Federal ESA petition. Under the Federal ESA, critical habitat is composed of the specific areas within the geographic area occupied by the species at the time it was listed, that contain the physical or biological features that are essential to the conservation of endangered and threatened species and that may need special management or protection. Critical habitat designations affect only Federal agency actions or federally funded or permitted activities. Critical habitat designations do not affect activities by private landowners if there is no Federal "nexus"—that is, no Federal funding or authorization. Federal agencies are required to avoid "destruction" or "adverse modification" of designated critical habitat. The ESA requires the designation of "critical habitat" for listed species when "prudent and determinable." (USDI FWS 2017). Critical habitat is requested to be designated surrounding and including all occurrences on Federal Lands. This should include patches large enough to limit effects of human actions to existing occurrences and to provide for vegetative reproduction to spread from existing occurrences.

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