

**Greene's tuctoria
(*Tuctoria greenei*)**

**5-Year Review:
Summary and Evaluation**



Photo Credit: Sarah Gordon

**U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California**

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5-YEAR REVIEW

Greene's tuctoria (*Tuctoria greenei*)

I. GENERAL INFORMATION

I.A. Methodology used to complete the review:

This review was prepared by the Sacramento Fish and Wildlife Office (SFWO) of the U.S. Fish and Wildlife Service (Service) using information from the 2005 *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Recovery Plan) (Service 2005), survey information from experts who have been monitoring various localities of this species, and the California Natural Diversity Database (CNDDDB 2007), which is maintained by the California Department of Fish and Game (CDFG). The Recovery Plan and personal communications with experts were our primary sources of information used to update the species status and threats sections of this review.

I.B. Contacts

Lead Regional or Headquarters Office – Diane Elam, Deputy Division Chief for Listing, Recovery, and Habitat Conservation Planning, and Jenness McBride, Fish and Wildlife Biologist, Region 8 (California and Nevada), 916-414-6464

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I.C. Background

I.C.1. FR Notice citation announcing initiation of this review: 72 FR 7064, February 14, 2007. We received no information from the public in response to this notice.

I.C.2. Listing history

Original Listing

FR notice: 62 FR 14338

Date listed: March 26, 1997

Entity listed: Species (*Tuctoria greenei*)

Classification: Endangered

I.C.3. Associated rulemakings:

Critical habitat for this species was proposed on September 24, 2002 (67 FR 60033). The final rule to designate critical habitat for the Greene's tuctoria was published on August 6, 2003 (68 FR 46684). A re-evaluation of non-economic exclusions from the August 2003 final designation was published on March 8, 2005 (70 FR 11140). An evaluation of economic exclusions from the August 2003 final designation was published on August 11, 2005 (70 FR 46924).

Administrative revisions were published on February 10, 2006 (71 FR 7117). Clarifications on

the economic and non-economic exclusions for the final designation of critical habitat were published on May 31, 2007 (72 FR 30269).

I.C.4. Review History

We have not conducted any status reviews for this species since listing. Updated information on its status and threats was included in the 2005 Recovery Plan.

I.C.5. Species' Recovery Priority Number at start of review:

The recovery priority is 2C (based on a 1-18 ranking system where 1 is the highest recovery priority and 18 is the lowest) because the degree of threat and recovery potential is high and a taxonomic rank of full species. The "C" after the number 2 indicates the conflict of the species with development projects or other ground-disturbing activities.

I.C.6. Recovery Plan or Outline

Name of plan: Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon
Date issued: December 15, 2005

II. REVIEW ANALYSIS

Species Overview

The genus *Tuctoria* is in the grass family (Poaceae), subfamily Chloridoideae, and is a member of the tribe Orcuttieae, which also includes *Neostapfia* and *Orcuttia* (Reeder 1965). Like all plants in the Orcuttieae, Greene's tuctoria is dependent on vernal pools for survival. Unlike terrestrial grasses, grasses in the Orcuttieae have pith-filled stems, lack distinct leaf sheaths and ligules (scale-like leaf appendages), and produce exudate (Stone *et al.* 1988). The genus *Tuctoria* is characterized by flattened spikelets similar to those of *Orcuttia*, except that the spikelets of *Tuctoria* grow in a spiral, as opposed to a distichous (flattened), arrangement (Service 2005). *Tuctoria* species have short-toothed, narrow lemmas (scale-like appendages at florets), and the juvenile and terrestrial leaves of *Tuctoria* are similar to those of *Orcuttia*, but *Tuctoria* does not produce the floating type of intermediate leaves (Stone *et al.* 1988). Seed dormancy is apparently well-developed in all tribe Orcuttieae species, although seed dormancy beyond 5 years has not been documented (Griggs and Jain 1983). Greene's tuctoria is relatively less tolerant to long periods of water inundation compared to other species in the tribe Orcuttieae, and is typically found along the margins of deeper vernal pools instead of in the deeper portions of the pools (Stone *et al.* 1988). This species is more susceptible to grazing impacts and grasshopper outbreaks compared to other species in the tribe Orcuttieae (Griggs and Jain 1983; Stone *et al.* 1988).

Greene's tuctoria has been reported in ten counties, which include Shasta, Tehama, Butte, Glenn, San Joaquin, Stanislaus, Madera, Merced, Fresno, and Tulare. The Service is aware of 42 localities of this species (CNDDB 2007; Service 2005). For the purposes of this review, the Service refers to locations of known sites that this species occurs as "localities." In general, our

definition of “locality” does not necessarily coincide with a single vernal pool, nor do we think these groups necessarily represent biological populations. Rather, they are convenient for reference to various parts of the range. A single locality may be comprised of a single vernal pool, or multiple vernal pools within close proximity of each other (i.e., adjacent vernal pools).

Of the 42 known localities, only 21 localities are presumed to be extant (CNDDDB 2007; Service 2005). This species is believed to be extirpated from San Joaquin, Stanislaus, Madera, Fresno, and Tulare counties (CNDDDB 2007; Service 2005). These extirpations occurred primarily from conversion of habitat to agriculture and intensive grazing regimes (Stone *et al.* 1988; CNDDDB 2007). The largest concentration of the presumed extant localities are located in the Vina Plains area, in Tehama and Butte counties, where 11 localities are presumed extant (CNDDDB 2007). The next largest concentration of localities is in eastern Merced County, where five localities are presumed extant (CNDDDB 2007; Vollmar 2002). Stone *et al.* (1988) conducted the most recent comprehensive survey effort for this species, in which all known localities were visited in 1986 and 1987. According to the CNDDDB (2007), over 50 percent of the known localities have not been surveyed in the last 20 years. Because surveys have not been performed at many of these sites in over twenty years, the actual status of many of the localities is not known at this time. The majority of localities inhabited by Greene’s tuctoria are not protected. The only protected localities include five localities within The Nature Conservancy’s Vina Plains Preserve, in Tehama and Butte counties, and one locality at the Drayer Ranch Conservation Bank, in Merced County. Conversion of habitat to agriculture, intensive grazing during the plant’s flowering season (May to June), competition from weedy invasive plants, and possibly grasshopper predation threaten this species in many extant localities (Stone *et al.* 1988; Vollmar 2002; Service 2005; R. Schlising, CSU Chico, *in litt.*, 2007a; J. Silveira, Service, *in litt.*, 2007; CNDDDB 2007).

II.A. Application of the 1996 Distinct Population Segment (DPS) policy

II.A.1. Is the species under review listed as a DPS?

☐ Yes
☒ No

The Endangered Species Act (Act) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species if vertebrate wildlife. This definition limits listing as distinct population segments (DPS) to vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

II.B. Recovery Criteria

II.B.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

☒ *Yes*
☐ *No*

II.B.2. Adequacy of recovery criteria.

II.B.2.a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

☒ *Yes*
☐ *No*

II.B.2.b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

☒ *Yes*
☐ *No*

II.B.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.

General recovery criteria for Greene's tuctoria and 19 other listed plants and animals are described in the Recovery Plan (Service 2005). This Recovery Plan uses an ecosystem-level approach because many of the listed species and species of concern co-occur in the same natural ecosystem and share the same threats. The over-arching recovery strategy for Greene's tuctoria is habitat protection and management. The five key elements that comprise this ecosystem-level recovery and conservation strategy are: (1) habitat protection; (2) adaptive management, restoration, and monitoring; (3) status surveys; (4) research; and (5) public participation and outreach.

The Recovery Plan provides recovery criteria that either directly or implicitly address the four listing factors noted in the final rule to list the species: destruction, modification, or curtailment of habitat or range (factor A), disease or predation (factor C), inadequacy of existing regulatory mechanisms (factor D), and other man-made or natural factors affecting its continued existence (factor E). Factor B, overutilization for commercial, recreational, scientific, or education purposes, was not included as a threat in the listing rule and is not addressed in the Recovery Plan. Since the Recovery Plan has only recently begun to be implemented, species surveys and monitoring efforts that will provide data to evaluate progress towards recovery have yet to be implemented.

Downlisting/delisting criteria for Greene's tuctoria include:

1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species.

This criterion addresses Factor A¹.

1A. Suitable vernal pool habitat within each prioritized core area for the species is protected.

Core areas support high concentrations of federally listed vernal pool species and are representative of a given species' range, and are generally where recovery actions are focused. Core areas represent viable populations, and possibly even source populations of vernal pool species for larger metapopulations, that will contribute to the connectivity of habitat and thus increase dispersal opportunities between populations. More than one federally-listed vernal pool species may be found within a single core area, and the core areas encompass an area larger than just the location of Greene's tuctoria. In the Recovery Plan, the core areas that pertain to Greene's tuctoria include: (1) Western Modoc Plateau; (2) Oroville; (3) Richvale; (4) Vina Plains; (5) Sacramento National Wildlife Refuge (NWR); (6) Fresno; (7) Madera; (8) Merced; and (9) Waterford. These nine core recovery areas are distributed among four vernal pool regions: (1) Southern Sierra Foothills; (2) Northeastern Sacramento Valley; (3) Solano-Colusa; and (4) Modoc Plateau.

The Recovery Plan identifies specific percentages of suitable habitat to be protected in each of the nine core areas. Core areas are ranked as zone 1, 2, or 3 in order of their overall priority for recovery. Core areas containing Greene's tuctoria are included as both zones 1 and 2 in the Recovery Plan, with no core areas ranked as zone 3. For Greene's tuctoria, the Recovery Plan recommends that 95 percent of zone 1 and 85 percent of zone 2 core recovery areas be protected. Table 1 provides a summary of the four vernal pool regions that pertain to Greene's tuctoria, and the zone designations for each of the nine core areas.

To downlist the Greene's tuctoria, the Recovery Plan recommends that 95 percent of suitable Greene's tuctoria habitat in zone 1 and 85 percent of suitable Greene's tuctoria habitat in zone 2 core recovery areas be protected. In addition, the Recovery Plan recommends that 80 percent of known localities be protected. Neither of these criteria has been met. To delist Greene's tuctoria, the Recovery Plan recommends that 100 percent of all reintroduced populations be protected. The Recovery Plan states that five introductions should be implemented, and should include the Farmington and Madera core areas. Reintroductions should occur in vernal pool regions and soil types from which status surveys indicate the species has been extirpated. At this time, new populations have not been reintroduced. Therefore, this criterion has not been met.

¹ A) Present or threatened destruction, modification or curtailment of its habitat or range;
B) Overutilization for commercial, recreational, scientific, or educational purposes;
C) Disease or predation;
D) Inadequacy of existing regulatory mechanisms;
E) Other natural or manmade factors affecting its continued existence.

Table 1: Greene’s tuctoria core recovery areas.

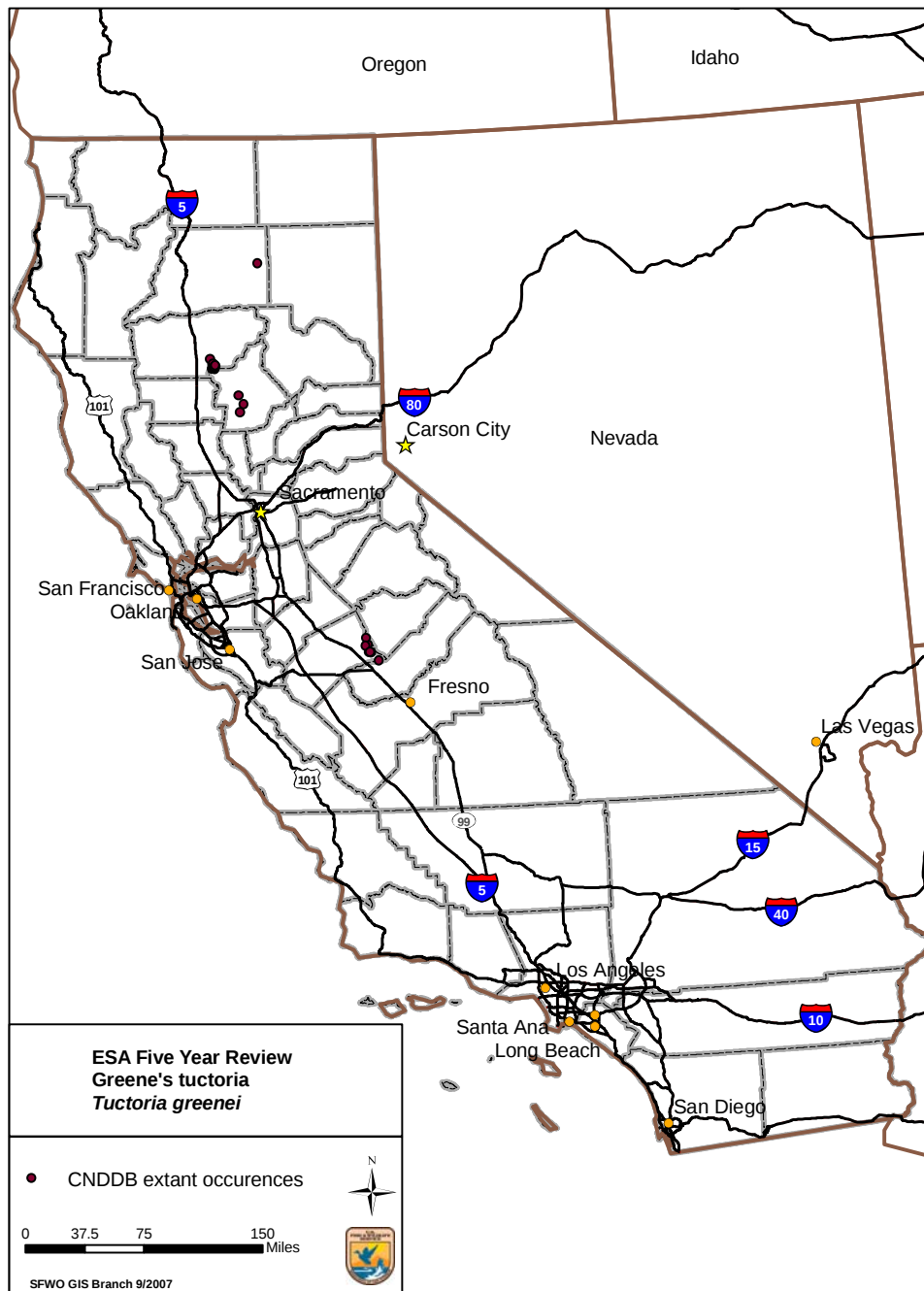
Modoc Plateau Vernal Pool Region Core area: Western Modoc Plateau (zone 2) (1 extant locality)
Northeastern Sacramento Valley Vernal Pool Region Core areas: Oroville (zone 1) (2 extant localities) Richvale (zone 2) (1 extant localities) Vina Plains (zone 1) (11 extant localities)
Solano-Colusa Vernal Pool Region Core areas: Sacramento NWR (zone 1) (1 potentially extant locality)
Southern Sierra Foothills Vernal Pool Region Core areas: Fresno (zone 2) (zero extant localities) Madera (zone 1) (six extant localities) Merced (zone 1) (zero extant localities) Waterford (zone 2) (zero extant localities)

The Service only recently approved the Recovery Plan and does not yet have sufficient information to quantify either the acreage of suitable habitat within each core area or the acreage of protected habitat that is suitable for Greene’s tuctoria. The amount of suitable habitat that exists range wide has not yet been estimated; therefore, the percent that has been protected range wide is still unknown. However, the vast majority of localities of this species are not protected. The only protected localities of this species include: (1) the Nature Conservancy’s Vina Plains Preserve, in Butte and Tehama counties; and (2) the Drayer Ranch Conservation Bank, in Merced County. There is one locality of this species at the Sacramento NWR, but it is likely extirpated since it hasn’t been detected since 1996. However, if Greene’s tuctoria is detected at some point in the future, this locality would also be protected.

1B. Species localities distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there.

This criterion has been partially met. Greene’s tuctoria is still known to occur in the following vernal pool regions (from north to south): Modoc Plateau, Northeastern Sacramento Valley, and Southern Sierra Foothills. There are five protected localities in the Northeastern Sacramento Valley region, in the Vina Plains Preserve, Tehama and Butte counties. There is one protected locality within the Southern Sierra Foothills region, within the Drayer Ranch Conservation Bank, in Merced County. The extirpated population within the Sacramento NWR, Glenn County, is within the Solano-Colusa region. Greene’s tuctoria has been extirpated from Glenn, San Joaquin, Stanislaus, Madera, Fresno, and Tulare counties (CNDDDB 2007).

The extreme edges of this species range are not protected. The northern-most locality occurs in Shasta County and this locality is on private land and not protected. Extirpated localities in Madera, Fresno, and Tulare counties once represented the southern extent of this species’ range. Currently, the southernmost localities of this species are in Eastern Merced County, where only one of five localities is protected within the Drayer Ranch Conservation Bank (Figure 1).



1C. Reintroduction and introductions must be carried out and meet success criteria.

This recovery criterion has not been met. The Recovery Plan recommends introduction of Greene's tuctoria to vernal pool regions and soil types from which status surveys indicate the species has been extirpated. This species has been extirpated from San Joaquin, Stanislaus, Madera, Fresno, and Tulare counties (CNDDB 2007). The Recovery Plan specifically states that five reintroductions should occur in the Farmington core area, in Stanislaus County, and the Madera core area, which is in Madera, Merced, and Mariposa counties. Griggs (1980) introduced abundant Greene's tuctoria and slender Orcutt grass (*Orcuttia tenuis*) seeds in an artificially constructed vernal pool at the University of California (U.C.) Davis (plastic sheets were used to simulate a hardpan) and at two human-made impoundments along a gravel road in Chico, Butte County. Slender Orcutt grass successfully grew at all locations (although in very small numbers at both pools in Chico), but Greene's tuctoria was not present at any of the three sites. It is unknown at this time if Greene's tuctoria is more difficult to introduce than other species in the tribe Orcuttieae (see discussion of poor colonizing ability in section II.C.2.e.: Other natural or manmade factors affecting its continued existence).

1D. Additional localities that are detected (and determined essential to recovery goals) are permanently protected.

This recovery criterion has been partially met. At this time, the Service is aware of five additional localities that have been discovered since the species was listed in 1997. These additional localities include one in Shasta County, one in Tehama County, one in Butte County, and two in Merced County. Of these five localities, only the Tehama County locality is currently protected; this one locality is located within the Vina Plains Preserve. The other four localities are essential to the recovery goals for this species and should be permanently protected to ensure the recovery of this species, particularly the Shasta County and Merced County localities, as these are within the extreme edges of this species' range.

1E. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring.

This criterion has not been met. Monitoring of hydrology has not occurred at any of the known extant populations; therefore the Service is unable to determine whether the hydrology at extant locations has supported viable populations through a variety of hydrologic conditions.

2. Adaptive Habitat Management and Monitoring

This criterion implicitly addresses Factors A, D, and E.

2A. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E.

This criterion has been partially met. The Vina Plains Preserve is managed under the 2006 *Vina Plains Preserve 2-year Resource Management Plan* (R. Reiner, The Nature Conservancy, pers. comm., 2007). Although Greene's tuctoria has not been observed on the Sacramento NWR since 1996, a Comprehensive Conservation Plan will be finalized for the Sacramento NWR in August 2008, which will address management issues for vernal pool species (J. Silveira, *in litt.*, 2007). The Drayer Ranch Conservation Bank is managed under the April 28, 2005, *Drayer Ranch Conservation Bank Management Plan* (Live Oak Associates 2005).

2B. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc).

This criterion has not been met. The Vina Plains Preserve does not have an endowment fund or other mechanism to provide for management in perpetuity and long-term monitoring. The Drayer Ranch Conservation Bank has an endowment fund to ensure management in perpetuity and long-term monitoring. Although this species is possibly extirpated from the Sacramento NWR, funding for management and protection of vernal pool species is allocated to the NWR annually.

2C. Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring.

Monitoring of ecosystem function has not occurred for any of the known populations of this species; therefore, the Service is unable to determine if the ecosystem function has been maintained at extant locations that have supported viable populations through a variety of hydrologic conditions. It is probable that many of the protected sites have functional ecosystems that would meet the requirements specified in this recovery criterion.

2D. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria.

This criterion has been partially met. Dr. Heather Davis, Department of Biology of Sonoma State University, began an investigation in 2007 on the population genetics of Greene's tuctoria and four other listed vernal pool plants (see Section 4A, below). Seeds have been collected at localities in Tehama and Glenn counties, and will continue to be collected in subsequent years at other localities (Heather Davis, *in litt.*, 2007). Seeds will be deposited at an appropriate seed storage facility.

3. Status Surveys:

This criterion implicitly addresses Factors A, D, and E.

3A. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of

reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring.

Monitoring has not occurred during a time period that meets the requirements specified in the Recovery Plan; therefore, this criterion has not been met at this time. Annual surveys for this species do not occur at any of the known localities for this species. Informal status surveys have occurred at the following sites; the Vina Plains Preserve (R. Schlising, *in litt.*, 2007a, 2007b), Sacramento NWR (J. Silveira, *in litt.*, 2007), Drayer Ranch Conservation Bank (Live Oak Associates 2005), and various localities in Merced County (Vollmar 2002). For these sites, biologists have noted the number of plants observed when out in the field, but no standardized site assessments exist for any of the sites.

Vernal pool region working groups will be important for tracking the progress of recovery efforts, including monitoring the status of populations of this species, particularly on private lands that are not currently monitored.

3B. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated.

Systematic habitat monitoring has not occurred at any of the known localities of Greene's tuctoria during or since the listing process. However, informal status surveys have occurred during various years at the following sites: the Vina Plains Preserve (R. Schlising, *in litt.*, 2007a, 2007b), the Sacramento NWR (J. Silveira, *in litt.*, 2007), Drayer Ranch Conservation Bank (Live Oak Associates 2005), Murken Lake in Shasta County (L. Cavaille, USFS, *in litt.*, 2007), and various localities in Merced County (Vollmar 2002). Informal monitoring indicates that the threats to this species described in the 1997 listing rule are still present, including impacts from agriculture practices, intensive grazing practices, and competition from invasive weed species (Vollmar 2002; R. Schlising, *in litt.*, 2007a; J. Silveira, *in litt.*, 2007). Grasshopper predation was discussed in the 1997 listing rule but was not considered a threat at that time. It is discussed as a potential threat in the Recovery Plan (Service 2005). Informal surveys and monitoring indicate that this threat has not been ameliorated or eliminated (R. Schlising, *in litt.*, 2007a, 2007b).

4. Research:

Research implicitly addresses all relevant listing factors.

4A. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat

protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions.

The Recovery Plan discusses a variety of research that would be beneficial to help refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts (pages IV-53 to IV-63). The Recovery Plan recommends research on genetics, taxonomy, biology of vernal pool species, the effects of habitat management practices on vernal pool species and their habitat, and threats to vernal pool species and ecosystems.

Currently, this criterion has been initiated, although the majority of information needs discussed in the Recovery Plan are still outstanding. Dr. Heather Davis, Department of Biology of Sonoma State University, began an investigation in 2007 on the population genetics of Greene's tuctoria and four other listed vernal pool plants to determine how pollination ecology interacts with population genetics to control the plant's reproductive success (Sonoma State University 2006).

4B. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in sections 1A-E.

See 4A, above.

4C. Research necessary to determine appropriate parameters to measure population viability for each species have been completed.

See 4A, above.

5. Participation and outreach:

Public participation and outreach implicitly address all relevant listing factors.

5A. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts.

The Recovery Plan discusses a variety of participation programs to achieve the goal of recovery of the listed species in the plan. An essential component of this collaborative approach is the formation of a single recovery implementation team overseeing the formation and function of multiple working groups formed at the vernal pool region level. The Service is currently in the preliminary stages of organizing both a recovery implementation team and multiple working groups. Service employees have met with various stakeholders to determine their interest in joining working groups and/or the recovery implementation team. This criterion has not been met.

5B. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts.

See 5A, above.

5C. Participation plans for each vernal pool region have been completed and implemented.

This action has not been initiated.

5D. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4.

This action has not been initiated.

II.C. Updated Information and Current Species Status

II.C.1. Biology and Habitat

II.C.1.a. Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Informal status surveys have occurred at the following sites: the Vina Plains Preserve, the Sacramento NWR, Drayer Ranch Conservation Bank, Murken Lake in Shasta County, and various localities in Merced County. Monitoring has not been sufficient to quantify abundance and identify trends, especially because population numbers for this species vary widely from year to year (Stone *et al.* 1988; Griggs 1980; R. Schlising, *in litt.*, 2007a). For the 21 extant localities of this species, the CNDDDB (2007) indicates that four localities have decreasing trends, one locality has a stable trend, and the remaining localities are listed as unknown. All localities in Merced County are declining in both plant numbers and size of habitat, primarily due to agricultural conversion and intensive grazing practices (Stone *et al.* 1988; Vollmar 2002). The locality at the Sacramento NWR has not been detected since 1996 (J. Silveira, *in litt.*, 2007).

II.C.1.b. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historical range (e.g., corrections to the historical range, change in distribution of the species within its historical range, etc.):

Greene's tuctoria is known from only 21 extant localities; at the time of listing, there were 16 known extant localities. This species is currently found in three types of vernal pools: Northern Basalt Flow, Northern Claypan, and Northern Hardpan on both low and high terraces (Stone *et al.* 1988). Since the time of listing in 1997, five additional localities of Greene's tuctoria have been detected. Only one of these localities, the Shasta County locality, was within a vernal pool region where this species was not previously known to occur (the Modoc Plateau vernal pool region). This expanded the species' known range approximately 70 miles to the northeast. The locality at the Sacramento NWR is the only known population within the Solano-Colusa vernal pool region. Greene's tuctoria has not been detected there since 1996 (J. Silveira, *in litt.*, 2007).

II.C.1.c. Extant Localities

Following is a discussion of known localities of this species by county and core recovery area (from north to south):

Shasta County

There is one locality of Greene's tuctoria on private lands surrounded by the Lassen National Forest. This locality is within the Modoc Plateau vernal pool region, and more specifically, within the Western Modoc Plateau core area. The site is identified as Murken Lake, east of Highway 89. The site is at an elevation of 3,500 feet. Lassen National Forest botanists have performed surveys for this species at Murken Lake and approximately 2,500 plants were detected in 1993 and 1994. The population declined to 120 in 1996 and 35 in 1998 (B. Corbin, USFS, *in litt.*, 2000). Lassen National Forest botanists detected 100 to 120 plants in 2000, and 249 plants in 2005 (L. Cavaille, *in litt.*, 2007).

Tehama County

There are currently five protected localities of Greene's tuctoria within The Nature Conservancy's Vina Plains Preserve, in the Vina Plains core recovery area in Tehama County (CNDDDB 2007, R. Schlising, *in litt.*, 2007a). Some of these localities are threatened by swamp pickle grass (*Crypsis schoenoides*), a non-native invasive plant species (R. Schlising, *in litt.*, 2007a, 2007b). The localities within the Vina Plains Preserve are informally monitored and non-native plants are removed from the vernal pools, although not on an annual basis (R. Schlising, *in litt.*, 2007a, 2007b). Some of these localities have been completely consumed by grasshoppers during certain years (R. Schlising, *in litt.*, 2007a). There is one locality of this species located at the Laniger Lakes area, which is approximately five miles north of the Vina Plains Preserve on private land. Greene's tuctoria has not been detected at this locality since 1987 (LSA 2003). There are five other localities inhabited by this species in Tehama County, all in the general vicinity of the Vina Plains Preserve, which are on private lands and not protected (CNDDDB 2007). These localities are considered extant, although they have not been visited since the 1980s (CNDDDB 2007).

Butte County

Greene's tuctoria is known to occur in four locations within the Vina Plains, Richvale, and Oroville core recovery areas in Butte County. One locality is in northern Butte County, within close proximity of Tehama County and the Vina Plains Preserve. While not part of the Vina Plains Preserve proper, it is protected under a conservation easement held by the Nature Conservancy. There are three other localities in Butte County: the Richvale locality, the Pentz Road Property, and a locality near the Butte and Tehama county line and east of State Route (SR) 99. These three localities are on private lands and considered extant, although they have not been visited since the late 1980s (CNDDDB 2007).

Glenn County

There is one known locality within the Sacramento NWR, within the Sacramento NWR core recovery area. Greene's tuctoria was detected within the Sacramento NWR in a single vernal pool in 1994 (60 plants). It was present in 1995 (1 plant) and 1996 (5 plants). In 1996, late spring rains filled the pool during flowering and no plants survived. Since then, this species has not been located in the NWR and the vernal pool has become populated by the native alkali bulrush (*Scirpus maritimus*), which has likely out-competed the Greene's tuctoria (J. Silveira, *in litt.*, 2007). It is not known if this species is extirpated from the NWR at this time (J. Silveira, *in litt.*, 2007).

Merced County

According to Vollmar (2002) there are five extant localities of Greene's tuctoria within the Madera core recovery area Merced County. All of these localities have declining trends in both overall number of plants as well as area of suitable habitat within a given pool due to discing, heavy cattle grazing, invasion of weedy non-native plants, and flooding (Vollmar 2002). The number of individual plants observed at these localities varies considerably from year to year and plants are reported to be absent entirely during below-average rain years (Vollmar 2002). The localities in Merced County support 21 percent of all known localities of Greene's tuctoria and all remaining localities known from the San Joaquin Valley. As such, these localities are critical for the long-term conservation of the species (Vollmar 2002).

II.C.1.d. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Greene's tuctoria has been found in three types of vernal pools: Northern Basalt Flow, Northern Claypan, and Northern Hardpan. Occupied pools are or were underlain by iron-silica cemented harpan, tuffaceous alluvium, or claypan (Stone *et al.* 1988). Of pools where the species was known to be extant in 1987, the median size was 1.5 acres, with a range of 0.01 acre to 8.4 acres. Stone *et al.* (1988) noted that Greene's tuctoria grew in shallower pools than other members of the tribe or on shallow margins of deeper pools. The Central Valley pools containing Greene's tuctoria are in grasslands. The Shasta County locality is at a higher elevation and surrounded by pine forest. Elevations for this species range from 100 feet in Butte County to 3,500 feet in Shasta County (CNDDB 2007).

At the Vina Plains Preserve, Greene's tuctoria frequently co-occurs with such native plants as Great Valley button celery (*Eryngium castrense*) and hairy water clover (*Marsilea vestita*) (Alexander and Schlising 1997). Elsewhere in the Sacramento Valley and San Joaquin Valley, Greene's tuctoria often grows in association with Vasey's coyote thistle (*Eryngium vaseyi*) and stalked popcorn flower (*Plagiobothrys stipitatus*). Greene's tuctoria co-occurs with the federally-endangered Hoover's spurge (*Chamaesyce hooveri*) at eight sites in the Sacramento Valley (Service 2005). Other federally-listed plants that co-occur with Greene's tuctoria at a few localities are hairy Orcutt grass (*Orcuttia pilosa*), San Joaquin Valley Orcutt grass (*O. inaequalis*), slender Orcutt grass (*O. tenuis*), and Colusa grass (*Neostapfia colusana*) (Service 2005).

II.C.1.e. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.); taxonomic classification or changes in nomenclature:

There has been no new information on genetics or taxonomy since listing of this species in 1997, although a population genetics study has been initiated (Sonoma State University 2006).

II.C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms):

II.C.2.a. Present or threatened destruction, modification or curtailment of its habitat or range:

According to the 1997 listing rule, the remaining extant localities of this species were threatened by conversion to irrigated agricultural lands, intensive grazing practices, and competition from invasive plants (see Section II.C.2.e. for a discussion of grazing and competition from invasive plants).

Throughout the species' range, 73 percent of the 21 known extant Greene's tuctoria localities are on private land and are not protected (CNDDB 2007). Five localities in Tehama and Butte counties are within the Vina Plains Preserve, and are not threatened by habitat loss. The locality within the Drayer Ranch Conservation Bank, in Merced County, is also protected from habitat loss. In addition, the locality within the Sacramento NWR, in Glenn County, is also protected from habitat loss. All of the remaining localities are on private lands and not protected from habitat loss.

Stone *et al.* (1988) estimated that 66 percent of the pre-agricultural localities of Greene's tuctoria have been extirpated, primarily from the elimination of habitat through development of irrigated agriculture (Stone *et al.* 1988; CNDDB 2007). All of the Greene's tuctoria localities that were located on lower terrace or claypan soils have been extirpated, presumably because these soil types are relatively fertile and therefore more suitable for intensive agriculture (Stone *et al.* 1988). With the exception of the locality on the Drayer Ranch Conservation Bank, all of the localities of Greene's tuctoria remaining in the San Joaquin Valley (Merced County) are threatened by continuing agricultural development (Stone *et al.* 1988; Vollmar 2002). All of the remaining localities within Merced County have documented trends towards a decline in both overall numbers of plants as well as area of suitable habitat within a given pool due to discing, heavy cattle grazing, invasion of weedy non-native plants, and flooding (Vollmar 2002).

In addition, there are four localities of Greene's tuctoria within the U.C. Merced Campus project area, in Merced County (Jones and Stokes 2007). Although build-out of the U.C. Merced campus does not currently involve specific plans to destroy vernal pool habitat with known Greene's tuctoria, it is unknown at this time if future proposed development of the campus would indirectly affect the proximal Greene's tuctoria habitat. In addition, the U.C. Merced campus has contributed to an increase in development of commercial and residential subdivisions in the area. The City of Merced predicts that population growth will expand to 239,210 people by 2035

within the City, an increase from 60,900 individuals in 1990 (City of Merced 1997). Even if development does not result in the destruction of known localities of this species, this development will occur in areas adjacent to known occurrences of Greene's tuctoria. There is potential for development projects within close proximity to occupied Greene's tuctoria habitat to cause indirect effects resulting from increases deleterious substances (i.e., fertilizers, herbicides, and oil based products), human intrusion, habitat fragmentation, and modification of hydrology, even if the actual vernal pools are not filled.

II.C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes:

Overutilization was not known to be a threat to this species at the time of listing, and still does not appear to be a threat at this time.

II.C.2.c. Disease or predation:

Disease was not known to be a threat to this species at the time of listing, and is still not known to be a threat at this time.

Greene's tuctoria is more susceptible to grasshopper outbreaks than other species in the tribe Orcuttieae, possibly due to the lower amount of exudate found in this species compared to other species in the tribe (Stone *et al.* 1988). The 1997 listing rule discussed predation from grasshoppers as a possible threat to the species (62 FR 14338; Griggs and Jain 1983; Stone *et al.* 1988). The Service determined that grasshopper predation did not pose a serious threat to populations of Greene's tuctoria at that time because the Service was only aware of two records of grasshopper predation occurring. Griggs (1980) noted that Greene's tuctoria was completely consumed by grasshoppers in 1978 in several pools within the Vina Plains Preserve. In addition, seven of the nine extant Greene's tuctoria localities on the Vina Plains were significantly damaged by grasshopper predation in 1986 (Stone *et al.* 1988). One year after the species was listed in 1997, Schlising (in litt., 2007a) observed that grasshoppers consumed all but several plants in one pool, and all plants were consumed in three other pools within the Vina Plains Preserve. It is important to note that monitoring of this species only occurs infrequently, and three recorded instances of significant damage from grasshopper outbreaks since 1986 suggest that grasshopper predation may occur more often than what is recorded in monitoring data.

It appears that the seed banks for these localities are sufficiently persistent, at least for several years, to permit recovery of localities after grasshopper predation (R. Schlising, *in litt.*, 2007a). Griggs (1980) noted that Greene's tuctoria within the Vina Plains Preserve was abundant the year before and again the year after 1978, when the Greene's tuctoria was completely consumed by grasshoppers in some pools. Although the seed bank for this species enables these localities to recover after grasshopper outbreaks, grasshopper destruction, when compounded by other factors such as drought, intensive grazing, or competition from invasive plants, could lead to localized extirpations. Also see the discussion of drought, grazing, invasive plants, and small population size, in Section II.C.2.e.: Other natural or manmade factors affecting its continued existence.

II.C.2.d. Inadequacy of existing regulatory mechanisms:

In the final rule we identified the inadequacies of the Federal Clean Water Act, the California Environmental Quality Act, and conservation easements.

Federal Laws

The Endangered Species Act of 1973, as amended (Act), is the primary Federal law that provides protection for Greene's tuctoria. Section 7(a)(2) requires Federal agencies to consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize a listed species. Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the "take" of federally endangered wildlife; however, plants are not protected against take. Instead, plants are protected from harm in two particular circumstances. Section 9 prohibits (1) the removal and reduction to possession (i.e. collection) of endangered plants from lands under Federal jurisdiction, and (2) the removal, cutting digging, damage, or destruction of endangered plants on any other area in knowing violation of a state law or regulation. The protection of Section 9 afforded to endangered species is extended to threatened wildlife and plants by regulation. Federally listed plants may be incidentally protected if they co-occur with federally listed wildlife species.

Under the terms of section 7(b)(4) and section 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an incidental take statement. Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species because take of plants is not prohibited. However, limited protection of listed plants from take is provided to the extent that the Act and the implementing regulations prohibit the removal and reduction to possession of federally listed threatened or endangered plants or the malicious damage of endangered plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas when in violation of state law or regulation or in the course of any violation of a state criminal trespass law.

The National Environmental Policy Act (NEPA) (42 U.S.C. 4321 *et seq.*) may afford some protection to populations affected by Federal activities. The NEPA requires all Federal agencies to formally document, consider, and publicly disclose the environmental impacts of Federal actions and management decisions affecting the human environment. NEPA requires agencies to consider mitigation alternatives, but does not require or guide the actual implementation of mitigation for impacts.

Currently there are no completed regional or county-wide Habitat Conservation Plans (HCPs) authorized under section 10 of the Act, or Natural Community Conservation Plans (NCCPs) authorized under the California Natural Community Conservation Plan Act, in Shasta, Tehama, Butte, or Merced Counties, thereby leaving populations on private land without protection under these laws.

Federal Clean Water Act: The Section 404 of the Clean Water Act (CWA) may afford some protection to Greene's tuctoria. The U.S. Army Corps of Engineers (Corps) issues permits for

the discharge of dredged or fill material into navigable waters of the United States. The Corps interprets “the waters of the United States” expansively to include not only traditional navigable waters, but also other defined waters that are adjacent or hydrologically connected to traditional navigable waters. Before issuing a 404 permit for a project that may affect federally listed species, the Corps is required under section 7 of the Act to consult with the Service.

However, recent Supreme Court rulings have called into question the Corps’ definition of waters of the U.S. On June 19, 2006, the U.S. Supreme Court vacated two district court judgments that upheld this interpretation as it applied to two cases involving “isolated” wetlands. Currently, the Corps regulatory oversight of vernal pools is in doubt because of their “isolated” nature. In response to the Supreme Court decision, the Corps and the U.S. Environmental Protection Agency (USEPA) have recently released a memorandum providing guidelines for determining jurisdiction under the CWA. The guidelines provide for a case-by-case determination of a “significant nexus” standard that may protect some, but not all, vernal pool habitat (USEPA and USACE 2007). The overall effect of the new permit guidelines on loss of vernal pool habitat is not known at this time. If the Corps loses their regulatory authority over vernal pools, unmitigated destruction of potential habitat for Greene’s tuctoria may increase over the range of the species.

California State Laws: The State’s authority to conserve wildlife is comprised of the California Endangered Species Act (CESA) and the California Environmental Quality Act (CEQA). Greene’s tuctoria was listed as endangered under CESA in 1979. As stated earlier, the Federal ESA does not authorize take for the destruction of endangered plants on non-Federal areas in violation of State law. Therefore, the CESA would offer protection at the State level if Greene’s tuctoria were not federally endangered. CEQA (chapter 2, section 21050 *et seq.* of the California Public Resources Code) requires government agencies to consider and disclose environmental impacts of projects and to avoid or mitigate them where possible. Under CEQA, public agencies must prepare environmental documents to disclose environmental impacts of a project and to identify conservation measures and project alternatives. Through this process, the public can review proposed project plans and influence the process through public comment. If a project may impact known populations of Greene’s tuctoria, these impacts would be disclosed to the Service and allow the Service an opportunity to comment on the proposed project’s effects to this species. Typically, project proponents propose conservation measures to offset or minimize adverse effects to listed species. However, CEQA does not guarantee that such conservation measures will be implemented.

II.C.2.e. Other natural or manmade factors affecting its continued existence:

The 1997 listing rule states that competition from invasive plant species and improper grazing regimes are threats to Greene’s tuctoria. Current threats include those discussed in the 1997 final rule, as well as climate change/drought, small population size, and poor colonizing ability.

Invasive Plant Species: Competition from invasive plant species poses a primary threat to this species. The non-native swamp pickle grass threatens multiple localities within the Vina Plains Preserve (R. Schlising, *in litt.*, 2007a, 2007b) and the native alkali bulrush, along with other factors, has likely contributed to the disappearance of Greene’s tuctoria at the Sacramento NWR

since 1996 (J. Silveira, *in litt.*, 2007). Stone *et al.* (1988) report multiple localities that are threatened by competition from non-native invasive plants such as Italian ryegrass (*Lolium multiflorum*), hood canary grass (*Phalaris paradoxa*), and rabbitsfoot (*Polypogon monspeliensis*), as these plants typically are found along the margins of vernal pools, where Greene's tuctoria is also commonly found. All localities in Merced County are also threatened by invasive plant species (Vollmar 2002).

Grazing: Intensive cattle grazing regimes are one of the primary causes of extirpation among known localities of Greene's tuctoria (Stone *et al.* 1988; CNDDDB 2007). Stone *et al.* (1988) noted that improper grazing management was responsible for the extirpation of at least eight localities during field visits in 1986 and 1987, and they found that even under a moderate grazing regime many extant localities of this species were damaged or declining. Greene's tuctoria is more susceptible to negative grazing impacts compared to other species in the tribe Orcuttieae, as Greene's tuctoria is more commonly found along the marginal edges of vernal pools, while other species in this tribe are more tolerant of inundation and are found in the deeper portions of vernal pools (Stone *et al.* 1988). Because Greene's tuctoria is commonly found along the edges of pools, this makes this species more susceptible to livestock trampling, especially early in the season when cattle are still present (Stone *et al.* 1988). In this event, cattle may severely trample the drying mud of the pool bed, causing soil disturbance and, indirectly, reduce the density of Greene's tuctoria seedlings (Stone *et al.* 1988). This phenomenon is exacerbated during low rainfall years (Stone *et al.* 1988). In addition, trampling by cattle may also contribute to the establishment of weedy, non-native plants (Stone *et al.* 1988). Greene's tuctoria at Vina Plains increased in numbers when cattle were removed from vernal pool areas before May or June, when Greene's tuctoria begins to seed (Griggs 2000). Cattle on the Vina Plains Preserve and Drayer Ranch Conservation Bank are managed for the protection of Greene's tuctoria. Heavy cattle grazing is cited as a threat for the locality at Murken lake, in Shasta County (CNDDDB 2007). The Service is not aware of how grazing management practices are conducted at other localities.

Climate Change/Drought: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field *et al.* 1999, Cayan *et al.* 2005, IPCC 2007, Pyke 2005). However, climatic conditions for smaller sub-regions such as California remain uncertain (Pyke 2005). It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). Greene's tuctoria is dependent upon vernal pool wetlands, which signifies the importance of water availability on the survival and recovery for this species. If California receives more rainfall through intense precipitation events, suitable vernal pool habitat for Greene's tuctoria may increase, which would benefit the species. However, if California enters into a drying trend, the resulting droughts could adversely affect Greene's tuctoria. It is common for this species not to appear during below-average rainfall years (Griggs 1980; Griggs and Jain 1983; Stone *et al.* 1988; Vollmar 2002).

While drought conditions are a normal part of environmental variability in California, a severe drought would exacerbate adverse effects associated with small, disjunct populations of Greene's tuctoria, and would place additional strains on vernal pool ecosystems. Where populations

persist on only marginal habitat, the addition of drought conditions is likely to result in high rates of mortality in the short term, with the effects of low reproductive output and survivorship persisting after the drought has ceased. It is unknown how quickly Greene's tuctoria populations may rebound after a severe drought; however, seed dormancy is apparently well developed in this species, and at most locations seed storage in the soil probably represents an effective barrier to local extinction from extended drought (Griggs 1980; Griggs and Jain 1983; Stone *et al.* 1988). In addition, this plant is highly adaptable to differing climatic conditions and will successfully grow in different portions of a pool (i.e., the margin or center) depending on the amount of water present in the vernal pool during a given year (Griggs 1980; Griggs and Jain 1983). However, a severe drought, if compounded by other factors such as grasshopper outbreaks, improper grazing regimes, invasive plant species, and other unforeseen circumstances, could contribute to the local extirpation of this species.

Small Population Size: Populations of Greene's tuctoria can vary greatly from year to year, with some extant localities not appearing during dry years and appearing the next year, under more favorable rainfall conditions, with plants numbering in the thousands (Stone *et al.* 1988). In many instances, localities of this species occur in relatively low numbers for consecutive years due to climatic conditions or other factors (Stone *et al.* 1988; Griggs 1980). The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom *et al.* 2006). In particular, small population size makes it difficult for this species to persist while sustaining the impacts from competition from non-native plant species, intensive grazing, drought, grasshopper predation, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987). If a locality of Greene's tuctoria has several consecutive years of poor rainfall, excessive grasshopper predation, intensive grazing, or intense competition from other plant species, it is possible that the locality will become extirpated. Populations that decline to zero may not always be capable of rebounding from the soil seed bank and the population may become extirpated (Service 2005). For example, CNDDDB locality number 39, in Stanislaus County, numbered fewer than 100 plants in 1973, dropped to two the following year, and remained at zero for the next three years (Griggs 1980; Griggs and Jain 1983). Plants were not observed at this locality in 1986 or 1987, although other Orcutt species were present (Stone *et al.* 1988). This locality is now assumed to be possibly extirpated (CNDDDB 2007). The locality at the Sacramento NWR serves as another example of this phenomenon. Greene's tuctoria was detected within the Sacramento NWR in a single vernal pool in 1994 (60 plants). It was present in 1995 (1 plant) and 1996 (5 plants). In 1996, late spring rains filled the pool during flowering and no plants survived. Since then, this species has not been located in the NWR and the vernal pool has become populated by alkali bulrush, which has likely out-competed the Greene's tuctoria (J. Silveira, *in litt.*, 2007).

Poor Colonizing/Recolonizing Ability: If any species is to persist, it must have the ability to colonize new localities (Griggs 1980). In addition, if a locality is extirpated from a vernal pool, recolonization would be necessary. Because of the isolated nature of the various localities of this species, the opportunities for recolonization are greatly reduced due to physical isolation from other source populations (Griggs 1980; Griggs and Jain 1983). Griggs (1980) introduced abundant Greene's tuctoria and slender Orcutt grass seeds in an artificially constructed vernal

pool at U.C. Davis (plastic sheets were used to simulate a hardpan) and at two human-made impoundments along a gravel road in Chico, Butte County. Slender Orcutt grass successfully grew at all locations (although in very small numbers at both pools in Chico), but Greene's tuctoria plants did not survive to an advanced stage at any of the three sites. Although not conclusive, these experiments suggest that it may be more difficult for Greene's tuctoria to establish itself in new localities compared to other species in the tribe Orcuttieae. Griggs (1980) determined Greene's tuctoria has a lower degree of morphological plasticity (variation related to environmental conditions) compared to that of slender Orcutt grass, which allowed the slender Orcutt grass to mature and survive long enough to set seed. Slender Orcutt grass, for example, possesses the ability for aquatic seedling growth and Greene's tuctoria does not (Griggs 1980).

II.D. Synthesis

When Greene's tuctoria was listed as endangered in 1997, the primary threats to its survival and recovery were conversion of habitat to agriculture, competition from non-native weed species, and impacts from intensive grazing practices. We have no new information to suggest that these threats to the species have substantially changed since the time of listing in 1997. The Service determined that grasshopper predation was not a threat to the species in the 1997 listing rule; however, it appears that grasshopper predation, when compounded by other negative factors, may pose a threat to this species, although to what degree is unknown at this time. In addition, other factors, such as drought, small population size, and poor colonizing/recolonizing ability, may also threaten this species. The majority of the localities of Greene's tuctoria do not have management plans, monitoring programs, or adequate funding to ensure that these localities are sustainable in perpetuity. Lack of management, monitoring, and funding are not, in themselves, threats to Greene's tuctoria; however, without these components, the potential threats described above may not be identified and eliminated.

The five localities within the Nature Conservancy's Vina Plains Preserve in Tehama and Butte counties, and the one locality at the Drayer Ranch Conservation Bank in Merced County, the one locality at the Sacramento NWR are the only localities of this species that are protected from development (i.e., land use conversion). Fourteen localities of this species remain unprotected and all of these sites are on private lands. With the exception of the locality on the Drayer Ranch Conservation Bank, all of the populations of Greene's tuctoria remaining in the San Joaquin Valley (Merced County) are threatened by continuing agricultural development (Stone *et al.* 1988; Vollmar 2002). Other than habitat preservation, other criteria discussed within the Recovery Plan have not been met, and in some instances, not initiated, including research, monitoring, management, and public participation and outreach. Based on the continuing threat of habitat loss due to agriculture practices, invasive weeds, intensive cattle grazing, and the potential indirect effects of development associated with U.C. Merced, we conclude that Greene's tuctoria still meets the ESA definition of endangered. No status change is recommended at this time.

III. RESULTS

III.A. Recommended Classification:

- ☐ **Downlist to Threatened**
- ☐ **Uplist to Endangered**
- ☐ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11*):
 - ☐ *Extinction*
 - ☐ *Recovery*
 - ☐ *Original data for classification in error*
- ☒ **No change is needed**

III.B. New Recovery Priority Number: No change.

We recommend that the recovery priority number remain 2C.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

The following recommendations for future actions are from the 2005 Recovery Plan and the results of discussions on the status of the species and the species' needs with several recognized Greene's tuctoria experts:

1. The five localities within the Nature Conservancy's Vina Plains Preserve in Tehama and Butte counties, and the one locality at the Drayer Ranch Conservation Bank in Merced County currently are protected and managed for the benefit of this species. If more localities of Greene's tuctoria are protected and managed properly, the probability of stochastic catastrophes wiping out the species will decrease (Griggs and Jain 1983). Protection of additional localities of this species is necessary to recover this species. Protecting localities in the San Joaquin Valley (Merced County) should be a priority over the next five years, as this is the southern extent of the species range, and only one locality (Drayer Ranch) is protected at this time. The occurrence at Murken Lake, Shasta County should also be a priority over the next five years for protection as this is the northern extent of this species range.
2. Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans.
3. Conduct research at as many of the extant localities as possible to incorporate research recommendations outlined in the 2005 Recovery Plan. The following research should be prioritized over the next five years:

- a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats.
 - b. Conduct research on invasive weedy plant species to determine the most appropriate methods to control these plants and increase population numbers of Greene's tuctoria and other Orcuttia grasses.
 - c. Conduct research on the genetic structure of the species to determine the feasibility of introducing Greene's tuctoria to biologically appropriate vernal pool regions and soil types from which status surveys indicate the species has been extirpated.
4. Regional vernal pool working groups should be created in regions where Greene's tuctoria is known to occur to aid with monitoring and management efforts.

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**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF GREENE'S TUCTORIA**

Current Classification: Endangered
Recommendation resulting from the 5-Year Review

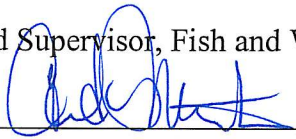
☐ Downlist to Threatened
☐ Uplist to Endangered
☐ Delist
☒ No change is needed

Appropriate Listing/Reclassification Priority Number, if applicable N/A

Review Conducted By Sacramento Fish and Wildlife Office Staff

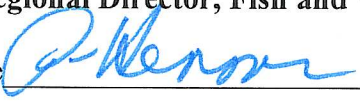
FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve  Date 10/29/07

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve  Date 1/10/08