

Two localities for *Navarretia leucocephala* ssp. *plieantha* are protected as reserves. The Trust for Wildland Communities manages the Boggs Lake Preserve and the California Department of Fish and Game manages the Loch Lomond Vernal Pool Ecological Reserve. Management activities at the two reserves include annual monitoring, protective measures such as fencing, and removal of competitors, and interpretive displays (Baldwin and Baldwin 1991; California Department of Fish and Game 1991, 1994).

Additional past conservation efforts included a 1985 survey throughout the range of *Navarretia leucocephala* ssp. *plieantha* (California Department of Fish and Game 1987b) and a survey in the Santa Rosa area of Sonoma County in 1988 (Waaland and Vilms 1989). Please refer to the Draft Santa Rosa Plains Recovery Plan (in development) for specific information regarding *Navarretia leucocephala* ssp. *plieantha* conservation efforts.

## 8. *NEOSTAPFIA COLUSANA* (COLUSA GRASS)

### a. Description and Taxonomy

**Taxonomy.**—Colusa grass is a member of the subfamily Chloridoideae in the grass family (Poaceae) and is in the Orcuttieae tribe, which also includes *Orcuttia* and *Tuctoria* (Reeder 1965, Keeley 1998). Davy (1898) first described Colusa grass, giving it the Latin name *Stapfia colusana*. He had collected the type specimen near the town of Princeton in Colusa County. Davy soon realized that the name *Stapfia* had already been assigned to a genus of green algae and therefore changed the scientific name of Colusa grass to *Neostapfia colusana* (Davy 1899). The name *Anthochloa colusana* was used for decades after Scribner (1899) published the combination in the mistaken belief that Colusa grass was closely related to a South American species of that genus. However, Hoover (1940) evaluated the many differences between *Anthochloa* and *Neostapfia* and concluded that the latter should be considered a distinct genus. Since that time, the accepted name for Colusa grass has been *Neostapfia colusana*. No other species of *Neostapfia* are known (Reeder 1982, Reeder 1993). *Neostapfia* is the most primitive member of the tribe (Keeley 1998).

**Description and Identification.**—All members of the Orcuttieae share several characteristics that differ from many other grasses. Most grasses have hollow stems, but the Orcuttieae have stems filled with pith. Another difference is that the Orcuttieae produce two or three different types of leaves during their life cycle, whereas most grasses have a single leaf type throughout their life span. The juvenile leaves of the Orcuttieae, which form underwater, are cylindrical and clustered into a basal rosette. After the pool dries, terrestrial leaves form in all

species of the tribe; these leaves have flattened blades and are distributed along the stem (Keeley 1998). *Orcuttia* species have a third type of leaf that is not found in *Neostapfia* or *Tuctoria* (Reeder 1982, Keeley 1998). The terrestrial leaves of the Orcuttieae also differ from other grasses in other respects. Whereas grass leaves typically are differentiated into a narrow, tubular sheath that clasps the stem tightly and a broader blade that projects away from the stem, terrestrial leaves of the Orcuttieae are broad throughout and the lower portion enfolds the stem only loosely. The Orcuttieae also lack a ligule, which is a leaf appendage commonly found in other grasses (Reeder 1965, Reeder 1982, Keeley 1998). Another characteristic common to all Orcuttieae is the production of an aromatic exudate, which changes from clear to brown during the growing season (Reeder 1965, Reeder 1982). The exudate most likely helps to repel herbivores (Crampton 1976, Griggs 1981).

The Orcuttieae are, however, similar to other grasses in their flower structure. Grasses do not have petals and sepals like most other flowering plants, so their flowers are inconspicuous. Grass flowers are reduced to florets, which include several stamens (three in the Orcuttieae) and one pistil enclosed in two scales known as the lemma and palea. A spikelet consists of one or more florets and may have one or two glumes at its base. The grass inflorescence typically includes several to many spikelets, which are attached to a central stem known as the rachis. A grass fruit, which is known as a caryopsis or grain, consists of a single seed fused to the fruit wall. Each floret is capable of producing one grain.

Compared to other members of the Orcuttieae, *Neostapfia colusana* (**Figure II-11**) shows fewer adaptations to existence underwater, indicative of its relatively primitive evolutionary position and the shorter duration of underwater growth (Keeley 1998). The aquatic seedlings of *N. colusana* have only one or two juvenile leaves (Keeley 1998). The terrestrial stage consists of multiple stems arising in clumps from a common root system. The stems are decumbent and have a characteristic zigzag growth form (Crampton 1976). Overall stem length ranges from 10 to 30 centimeters (3.9 to 11.8 inches). The entire plant is pale green when young (Davy 1898), but becomes brownish as the exudate darkens (Reeder 1982, Reeder 1993). Leaf length is 5 to 10 centimeters (2.0 to 3.9 inches) (Hitchcock and Chase 1971). Each stem produces one dense, cylindrical inflorescence that is 2 to 8 centimeters (0.8 to 3.1 inches) long and 8 to 12 millimeters (0.31 to 0.47 inch) broad. Within the inflorescence, the spikelets are densely packed in a spiral arrangement; the tip of the rachis projects beyond the spikelets. *Neostapfia colusana* has a diploid chromosome number of 40 (Reeder 1982, Reeder 1993).



**Figure II-11.** Illustration of *Neostapfia colusana* (Colusa grass). Reprinted with permission from Abrams (1940), *Illustrated Flora of the Pacific States: Washington, Oregon, and California*, Vol. I. © Stanford University Press.

Unlike terrestrial grasses, *Neostapfia colusana* has pith-filled stems, lacks distinct leaf sheaths and ligules, and produces exudate. *Neostapfia colusana* differs from other members of the Orcuttieae in that it has zigzag stems, cylindrical inflorescences, and fan-shaped lemmas and lacks glumes, whereas the other genera within the tribe have fairly straight stems and possess glumes. Moreover, *Orcuttia* species have distichous spikelets and narrow, five-toothed lemmas, and *Tuctoria* species have spikelets arranged in a loose spiral, and narrow, more-or-less entire lemmas. *Neostapfia colusana* is not likely to be confused with *Anthochloa*, despite their former taxonomic affiliation. The latter does not occur in North America, is perennial, does not have glands, the inflorescence is not cylindrical, and the spikelets have glumes (Hoover 1940).

## b. Historical and Current Distribution

**Historical Distribution.**—In the 50 years after its initial discovery (Davy 1898), *Neostapfia colusana* was reported from only three sites other than the type locality; these sites were in Merced and Stanislaus Counties. By 1989, 51 occurrences were known, but 11 of those had already been extirpated (Stone *et al.* 1988, California Natural Diversity Data Base 2003). Through November 2003, the California Natural Diversity Data Base (2003) included 60 reported occurrences of *N. colusana* in Colusa, Merced, Solano, Stanislaus, and Yolo Counties. Five each were reported from the San Joaquin Valley and Solano-Colusa Vernal Pool Regions, and the remainder were from the Southern Sierra Foothills Vernal Pool Region (**Figure II-12**).

**Current Distribution.**—Currently, no more than 42 occurrences of *Neostapfia colusana* remain extant (Hogle 2002, California Natural Diversity Data Base 2005). At least one population remains in each of the vernal pool regions from which *N. colusana* was known historically. The majority of extant occurrences are in the Southern Sierra Foothills Vernal Pool Region, where they are concentrated northeast of the City of Merced in Merced County and east of Hickman in Stanislaus County. One or two occurrences remain in central Merced County, which is part of the San Joaquin Valley Vernal Pool Region. Four occurrences are extant in the Solano-Colusa Vernal Pool Region, with two each in southeastern Yolo and central Solano Counties (Stone *et al.* 1988, Keeler-Wolf *et al.* 1998, California Natural Diversity Data Base 2003). This species has apparently been extirpated from Colusa County (California Natural Diversity Data Base 2005).

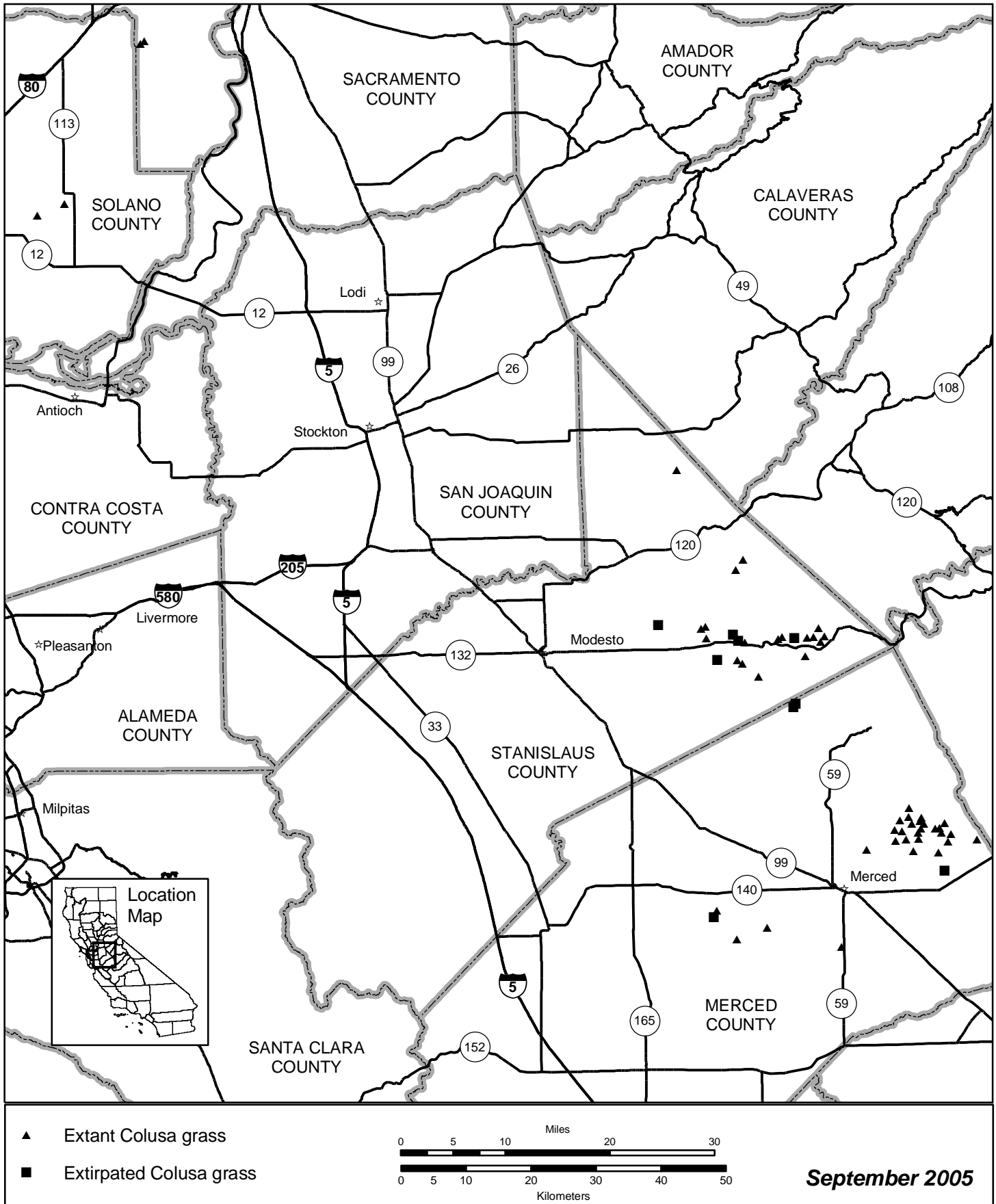


Figure II-12. Distribution of *Neostapfia colusana* (Colusa grass).

### c. Life History and Habitat

Many life history characteristics are common to all members of the Orcuttieae. In particular, they are all annuals (Griggs 1981). All are wind-pollinated, but pollen probably is not carried long distances between populations (Griggs 1980, Griggs and Jain 1983). Local seed (*i.e.*, caryopsis) dispersal is by water, which breaks up the inflorescences (Reeder 1965, Crampton 1976, Griggs 1980, Griggs 1981). Long-distance dispersal is unlikely (U.S. Fish and Wildlife Service 1985*a*), but seed may have been carried occasionally by waterfowl (family Anatidae), tule elk (*Cervus elaphus nannoides*), or pronghorn (*Antilocapra americana*) in historical times (Griggs 1980). The seeds can remain dormant for an undetermined length of time (but at least 3 to 4 years) and germinate underwater after they have been immersed for prolonged periods (Crampton 1976, Griggs 1980, Keeley 1998). Unlike typical terrestrial grasses that grow in the uplands surrounding vernal pools, members of the Orcuttieae flower during the summer months (Keeley 1998).

Among all members of the Orcuttieae, the soil seed bank may be 50 times or more larger than the population in any given year. In general, years of above-average rainfall promote larger populations of Orcuttieae, but population responses vary by pool and by species (Griggs 1980, Griggs and Jain 1983). Population sizes have been observed to vary by one to four orders of magnitude among successive years and to return to previous levels even after 3 to 5 consecutive years when no mature plants were present (Griggs 1980, Griggs and Jain 1983, Holland 1987). Thus, many years of observation are necessary to determine whether a population is stable, declining, or extirpated. All members of the Orcuttieae are endemic to vernal pools. Although the various species have been found in pools ranging widely in size, the vast majority occur in pools of 0.01 hectare (0.025 acre) to 10 hectares (24.7 acres) (Stone *et al.* 1988). Large pools such as these retain water until May or June, creating optimal conditions for Orcuttieae (Crampton 1959, 1976; Griggs 1981; Griggs and Jain 1983). Within such pools, Orcuttieae occurs in patches that are essentially devoid of other plant species (Crampton 1959, 1976). Typically, plants near the center of a pool grow larger and produce more spikelets than those near the margins, but patterns vary, depending on individual pool characteristics and seasonal weather conditions (Griggs 1980).

***Reproduction and Demography.***—In an experiment where *Neostapfia colusana* was grown along with *Tuctoria greenei* and two species of *Orcuttia* (Keeley 1998), seeds of *N. colusana* took about 3 months to germinate following inundation, longer than all other species. Hogle (2002) also provided evidence that long periods of inundation are necessary for germination of *N. colusana* seeds. Unlike *Orcuttia* species, *N. colusana* does not produce flattened, floating,

juvenile leaves (Reeder 1982, Keeley 1998). Germination and seedling development have not been studied in the wild, but are assumed to be similar to those of *Tuctoria* species, which have similar seedlings. Thus, *N. colusana* seed would be expected to germinate in late spring when little standing water remains in the pool, and flowering would begin approximately 3 to 4 weeks later, as observed for *Tuctoria* (Griggs 1980). Flowering individuals of *N. colusana* have been collected as early as May throughout the range of the species (California Natural Diversity Data Base 2005). *Neostapfia colusana* spikelets break between the florets (Reeder 1993), quickly shattering as soon as the inflorescence matures (Crampton 1976).

Reproductive and survival rates have not been reported, but annual monitoring confirms that population sizes of *Neostapfia colusana* vary widely from year to year. Over a 6-year monitoring period, the population at the Bert Crane Ranch in Merced County dropped from 250 plants in 1987 to zero in 1989 and 1990, but rebounded to over 2,000 plants in 1992 (J. Silveira *in litt.* 2000). At Olcott Lake in Solano County, the lowest population of the decade was 1,000 in 1994; but this low point was followed by a high of over 1 million estimated plants the following year (California Natural Diversity Data Base 2003).

***Habitat and Community Associations.***—*Neostapfia colusana* has the broadest ecological range among the Orcuttieae. It occurs on the rim of alkaline basins in the Sacramento and San Joaquin Valleys, as well as on acidic soils of alluvial fans and stream terraces along the eastern margin of the San Joaquin Valley and into the adjacent foothills (Stone *et al.* 1988). Elevations range from 5 meters (18 feet) to about 105 meters (350 feet) at known sites (California Natural Diversity Data Base 2005). *Neostapfia colusana* has been found in Northern Claypan and Northern Hardpan vernal pool types (Sawyer and Keeler-Wolf 1995) within rolling grasslands (Crampton 1959). It grows in pools ranging from 0.01 to 250 hectares (0.02 to 617.5 acres), with a median size of 0.2 hectare (0.5 acre), and also occurs in the beds of intermittent streams and in artificial ponds (Stone *et al.* 1988, K. Fuller pers. comm. 1997, EIP Associates 1999). This species typically grows in the deepest portion of the pool or stream bed (Crampton 1959, Stone *et al.* 1988), but may also occur on the margins (Hoover 1937, Stone *et al.* 1988). It appears that deeper pools and stock ponds are most likely to provide the long inundation period required for germination (EIP Associates 1999).

Several soil series are represented throughout the range of *Neostapfia colusana*. In the Solano-Colusa Vernal Pool Region, *N. colusana* grows on clay, silty clay, or silty clay loam soils in the Marvin, Pescadero, and Willows series. In the San Joaquin Valley Vernal Pool Region, soils are clay or silty clay loam in the Landlow and Lewis series (J. Silveira *in litt.* 2000). *Neostapfia colusana* habitat in the Southern Sierra Foothills Vernal Pool Region includes many soil series

with textures ranging from clay to gravelly loam. For sites with known soil series, Bear Creek, Corning, Greenfield, Keyes, Meikle, Pentz, Peters, Raynor, Redding, and Whitney are represented (Stone *et al.* 1988, EIP Associates 1999, California Natural Diversity Data Base 2003). The type and composition of impermeable layers underlying occupied vernal pools also varies, ranging from claypan to lime-silica or iron-silica cemented hardpan and tuffaceous alluvium (Stone *et al.* 1988).

*Neostapfia colusana* usually grows in single-species stands, rather than intermixed with other plants. Thus, associated species in this case are plants that occur in different zones of the same pools, but are generally present in the same season. For example, Crampton (1959) observed that *N. colusana* dominated pool beds, with *Orcuttia pilosa* forming a band around the upper edge of the stand. In saline-alkaline sites, common associates of *N. colusana* are *Frankenia salina* and *Distichlis spicata*, whereas on acidic sites associates include *Eryngium* spp., *Eremocarpus setigerus* (turkey mullein), and *Plagiobothrys stipitatus* (Stone *et al.* 1988, EIP Associates 1999). Many of the other rare plants featured in this recovery plan grow in the same pools as *N. colusana*. Among these species, the most frequent associate is *Orcuttia inaequalis*, followed by *O. pilosa*, *Tuctoria mucronata*, *Chamaesyce hooveri*, *Atriplex persistens*, and *Astragalus tener* var. *tener* (Stone *et al.* 1988, EIP Associates 1999, J. Silveira *in litt.* 2000, California Natural Diversity Data Base 2003). *Tuctoria greenei* formerly grew in one vernal pool with *N. colusana*, but the former no longer occurs there (Stone *et al.* 1988, California Natural Diversity Data Base 2003).

#### **d. Reasons for Decline and Threats to Survival**

Most species addressed in this recovery plan are threatened by similar factors because they occupy the same vernal pool ecosystems. These general threats, faced by all the covered species, are discussed in greater detail in the Introduction section of this recovery plan. Additional, specific threats to *Neostapfia colusana* are described below.

Three additional potential reasons for site-specific declines have been reported relative to this species: inundation by poultry manure and, in Yolo County, damage by herbicide applications (C. Witham *in litt.* 2000a) and contamination of groundwater by industrial chemicals (K. Fuller pers. comm. 1997).

The largest continuing threat to this species is agricultural conversion, especially in Stanislaus County. Urbanization is the second greatest threat, especially at the proposed University of California campus and associated community development in eastern Merced County. Four occurrences are in the area expected to be developed within the next 15 years and two others are within the



general “planning area” (EIP Associates 1999, California Natural Diversity Data Base 2003). Proposed construction of a new prison and a landfill also threaten other specific populations (U.S. Fish and Wildlife Service 1997a). A proposed flood control project in eastern Merced County threatens four of the occurrences with inundation, and runoff alterations are a threat to the two Yolo County occurrences. Almost all of the extant occurrences of *Neostapfia colusana* are subject to livestock grazing, thus to the extent inappropriate grazing practices are still being followed at certain sites, these sites may be threatened. Competition from invasive native and nonnative plants poses a problem at several sites, especially in combination with adverse hydrology changes and adverse grazing practices (Stone *et al.* 1988, C. Witham *in litt.* 2000a). One or two sites have also been reported as threatened by vandalism (*i.e.*, trampling near urban areas [U.S. Fish and Wildlife Service 1997a]) and foraging by grasshopper outbreaks (Stone *et al.* 1988). Small population size may be a threat at 9 sites, which have never exceeded 100 plants in number. In addition, several other sites that were formerly larger than 100 plants each now appear to have declined to fewer than that number of individuals (Hogle 2002, California Natural Diversity Data Base 2003).

#### **e. Conservation Efforts**

We listed *Neostapfia colusana* as a threatened species on March 26, 1997 (U.S. Fish and Wildlife Service 1997a). *Neostapfia colusana* has been State-listed as endangered since 1979 (California Department of Fish and Game 1991) and has been considered to be rare and endangered by the California Native Plant Society since 1974 (Powell 1974). The California Native Plant Society now includes *N. colusana* on List 1B and considers it to be “endangered throughout its range” (California Native Plant Society 2001). In 2005, critical habitat was designated for *N. colusana* and several other vernal pool species in *Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon; Evaluation of Economic Exclusions From August 2003 Final Designation; Final Rule* (U.S. Fish and Wildlife Service 2005).

Most of the conservation efforts for *Neostapfia colusana* have been accomplished as part of the broader effort to survey and protect vernal pools in the Central Valley. Surveys conducted by Crampton (1959), Medeiros (1976), and Stone *et al.* (1988) contributed to distributional records and identification of threats. Four occurrences of *N. colusana*, comprising six occupied pools, have been protected by The Nature Conservancy. One is Olcott Lake on the Jepson Prairie Preserve in Solano County, where the *N. colusana* population has been monitored annually since 1989 (C. Witham *in litt.* 1992, California Natural Diversity Data

Base 2003). The other five pools are on the Flying M Ranch conservation easement in eastern Merced County (Stone *et al.* 1988).

Three additional occurrences of *Neostapfia colusana* are on Federal land, which offers more options for conservation, but does not in itself constitute protection. Two are on a U.S. Department of Defense facility in Yolo County (Davis Communications Annex), which is in the process of being transferred to the ownership of Yolo County Parks (K. Fuller *in litt.* 2000). This site is the subject of a nonnative invasive plant management effort, particularly for *Lepidium latifolium* (pepperweed), and vernal pool restoration under a CalFed grant to benefit *N. colusana* and *Tuctoria mucronata*, another federally-listed plant included in this plan (N. McCarten *in litt.* 2004). The third occurrence on Federal land is on the Arena Plains Unit of the Merced National Wildlife Refuge in Merced County. Our National Wildlife Refuge system acquired the Arena Plains in 1992, and refuge personnel have been monitoring the *N. colusana* population annually since 1993. Although the refuge allowed grazing to continue on the Arena Plains after it was purchased, temporary electric fencing was placed around the *N. colusana* pool to exclude cattle in one year when the plant population was deemed to be particularly vulnerable (D. Woolington pers. comm. 1997, J. Silveira *in litt.* 2000).

## **9. ORCUTTIA INAEQUALIS (SAN JOAQUIN VALLEY ORCUTT GRASS)**

### **a. Description and Taxonomy**

**Taxonomy.**—Hoover (1936b) first published the scientific name *Orcuttia inaequalis* for San Joaquin Valley Orcutt grass. A 1935 collection from “Montpellier [sic], Stanislaus County” was cited as the type specimen (Hoover 1936b). Hoover (1941) subsequently reduced this taxon to a variety of California Orcutt grass (*Orcuttia californica*), using the combination *Orcuttia californica* var. *inaequalis*. Based on differences in morphology, seed size, and chromosome number, Reeder (1980) restored the taxon to species status, and the scientific name *Orcuttia inaequalis* is thus currently in use (Reeder 1993). *Orcuttia inaequalis* is a member of the grass family (Poaceae), subfamily Chloridoideae, and is in the tribe Orcuttieae (Reeder 1965). The genus *Orcuttia* is the most evolutionarily advanced group within the tribe (Keeley 1998, L. Boykin *in litt.* 2000). Alternative common names for this species are San Joaquin Valley orcuttia (Smith *et al.* 1980) and San Joaquin Orcutt grass (U.S. Fish and Wildlife Service 1985c).

**Description and Identification.**—Characteristics common to all members of the Orcuttieae were described earlier in this document in the *Neostapfia*