Colusa Grass
(Neostapfia colusana)


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Legal Status
Federal: Threatened.
State: Endangered.

CNDDB Rank: G3S3.1: Global Rank, G3 = Vulnerable: At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors. State Rank, S3 = Vulnerable: Vulnerable in the state due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation. State ranks in California often also contain a threat designation attached to the S-rank S3.1 = very threatened.

CNPS List: 1B.1; 1B: Rare, threatened, or endangered in California and elsewhere. 0.1: Seriously endangered in California.

Recovery Plan: Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005).

Species Description and Life History

Colusa grass (*Neostapfia colusana*) is a robust, tufted annual 10- to 30-cm (4- to 12-inches) tall and is a member of the Orcuttieae tribe, which also includes *Orcuttia* and *Tuctoria* (Reeder 1965, Stone 1988, Hickman 1993). The lower portions of the stems lie on the ground while the upper portions are erect and terminate in dense cylindrical, spike-like inflorescences that superficially resemble small ears of corn. Long term inundation of approximately three months is required for seed germination, and it appears that deeper pools and stock ponds are most likely to provide the long inundation period required (USFWS 2005). Seeds of Colusa grass germinate in very shallow water during late spring and plants begin flowering in May, June, or July depending on seasonal conditions (Woodward 1985, Anonymous (S.J.B.). 1990, Environmental Science Associates 2005, J. Gerlach unpublished data). 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). Among all members of the Orcuttieae, the soil seed bank may be 50 times or more larger than the population in any given year (USFWS 2005).

All plants in this tribe 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). Despite numerous accounts in the literature to the contrary, seedlings at the Yolo Grasslands Park site do produce long strap-like juvenile floating leaves, which casts doubt on its taxonomic characterization as a primitive relative of the *Orcuttia* genus (J. Gerlach unpublished data). Mature seeds are retained on the dead plants until the inflorescences disintegrate during the beginning of the wet season (J. Gerlach unpublished data).

Habitat Requirements and Ecology

Colusa grass is an annual plant that, in Yolo County, grows in turbid vernal pools on infertile and highly salt-affected soils of alkali sink habitat that are underlain by clay soils. Colusa grass occurs in a wide variety of habitats that include the following: small alkaline vernal pools within alkali sinks (100 m^2); large alkaline playas (250 Ha); small to large neutral to acidic vernal pools; depressions in intermittent drainages running on the Mehrten geological formation; and areas that pond due to human modified hydrology (Crampton 1959 and 1976, Woodward 1985, Stone 1988, Holland 2000, Cypher 2001, Hogle 2002, Environmental Science Associates 2005).

Colusa grass apparently has the broadest environmental tolerances of any species in the Orcuttieae tribe (Stone 1988). At the Yolo Grasslands Park site, Colusa grass grows on shrink/swell clay soils with high sodium and boron salt concentrations and a pH near 9 (J. Gerlach, unpublished data). Despite published accounts to the contrary, all of the San Joaquin populations are found on a variety of non-saline soils with pH ranging from 5.8 to 7.5. None of the measured physical parameters accounted for its presence or absence in vernal pools, so its distribution is thought to be strongly correlated with seed dispersal dynamics (Hogle 2002). At the Yolo Grasslands Park site, Colusa grass is found across both highly salt-affected white soils (scalds) with Solano grass (*Tuctoria mucronata*) and swamp timothy (*Crypsis schoenoides*), and with cupped downingia (*Downingia insignis*) and vernal pool popcornflower (*Plagiobothrys stipitatus*) (ESA 2005) on less salt affected soils.

In high rainfall years, it is also found in flood plains above vernal pools (ESA 2005). Although San Joaquin populations were distributed in different areas of vernal pools, plants with the highest seed production were generally found in shallow depressions on the bottoms of the playas (Hogle 2002). According to historical aerial photographs, the population at Yolo Grasslands Park currently exists in a series of shallow agricultural drainage ditches that were excavated through alkaline vernal pools and swales prior to 1937 (USDA 1937). These disturbed areas have not been reexcavated and are considered to be disturbed vernal pools.

Hydrology and soil materials, both rock and soil, are responsible for the unique patterns of species distributions in alkaline vernal pools and alkaline playas in Yolo County and Solano County. Williamson *et al*. (2005) and Rains *et al*. (2008) summarized the situation well with regard to parent material: “The vernal pools on clay-rich soils formed on alluvium derived from sedimentary and metasedimentary rocks of marine origin. The soils that developed on these sediments are fine grained, saline, and sodic. These soils support vernal pools that are perched surface water systems, have relatively saline, sodic, and turbid surface water, and may be nitrogen and light limited.” Other studies have confirmed the nitrogen and light limitations (Barclay and Knight 1981).

Because of its underlying and extremely unique geologic structure, the Jepson Prairie alkaline vernal pools and alkaline playas are much older than the alkaline vernal pools and alkaline playas in Yolo County (Graymer, Jones et al. 2002). Jepson Prairie owes its unique species assemblages and the continued existence of the alkaline playas and vernal pools to the presence of the underlying Montezuma Block (Band 1998). The inward-sloping sides of the block with increasing depth assures that the Montezuma Block pops up and floats like an iceberg among other crustal blocks without distorting. This unique characteristic has allowed this single flat piece of the earth’s crust to persist in the same location since the oceanic plate and its accompanying archipelago of volcanoes first crashed into the North American continent and has maintained the only opening from the Central Valley to the Pacific Ocean through the rapidly rising Coast Ranges (Band 1998). After the Montezuma Block rose above the ocean, it was covered by eroded materials from the Coast Ranges that became deeply weathered infertile soils and which are clearly visible in aerial photographs (Band 1998). An ancient river channel cut across the northern edge of the block and apparently deposited the clays that underlie the Jepson Prairie alkaline vernal pools and alkaline playas. The Montezuma Block later tilted slightly to the north, which raised the Jepson Prairie area slightly above the surrounding area, preventing the non-saline flood waters of the Sacramento River from flushing the salts present in its clays into the Delta.

In contrast, north of the Montezuma Block, the alkaline vernal pools and alkaline playas in Solano and Yolo Counties are located on a low alluvial terrace that formed above the Yolo Basin and Sacramento River Delta through the deposition of outwash clay materials when Putah Creek and Cache Creek flooded over their natural levees (Graymer, Jones et al. 2002). The spreading flood waters deposited coarser alluvium near the channels and fine clays further away from the main channels in calmer water. As the flood waters receded, the suspended clay and dissolved salts were deposited as a relatively thin surface coating across the lower portions of the alluvial terrace. Successive flood events deposited successive layers of clay and the flooding history of the terrace is recorded in the alternating bands of alluvial material (State of California 1987). Historically, these alkaline vernal pools and alkaline playas occurred on the terrace in a broad arc from the Montezuma Hills to Cache Creek and in the two basins in Yolo County between the coast range and the Dunnigan Hills/Plainfield Ridge anticline (U. S. Bureau of Soils 1909a, 1909b, Mann *et al.* 1911). As described above, the salts (sodium, boron, magnesium) and the clay minerals were transported to the terrace by the creeks and did not develop in-situ.

The clays deposited in the Jepson Prairie Preserve area are older than 10,000 years, at least 30 feet thick near Olcott Lake, and thin to 6 feet thick near Jepson Prairie’s northern edge (C. Witham per. com.). In contrast, the clay surface deposits at the Solano grass location in Yolo County could be as young as 60-years old and were periodically replenished by floodwaters from Putah Creek prior to the completion of Monticello Dam on Putah Creek, which altered the hydrology of the entire region. At the Yolo Grasslands Park site a former distributional branch of Putah Creek forms the largest drainage and the alkaline vernal pools or drainage ditches lie above the natural drainage (Department of the Air Force 1993, Environmental Science Associates 2005). Prior to the construction of the Monticello Dam, when Putah Creek routinely flooded, the site was submerged and the turbulent hydraulics of the floodwaters scoured basins and channels in the higher surfaces that became alkaline vernal pools and swales after the flood waters receded. The Monticello Dam and other diversions have eliminated the natural floods that created and maintained the alkaline vernal pools and alkaline playas.

Species Distribution and Population Trends

Distribution

Currently, there are no more than 42 known extant occurrences in Yolo, Solano, Merced, and Stanislaus counties (CNDDB 2008, Hogle 2002). The vast majority of these occurrences are in Stanislaus County (15 occurrences) and Merced County (22 occurrences). Five occurrences are protected, and include: (1) one occurrence at the Merced National Wildlife Area (NWR), in Merced County; (2) one occurrence on private lands protected by a conservation easement adjacent to the Merced NWR; (3) one occurrence at Jepson Prairie Preserve, in Solano County; and (4) two occurrences at the Yolo Grasslands Park, in Yolo County.

Colusa grass was collected from Solano County in 1958 by Beecher Crampton from Olcott Lake, which is now within the Solano Land Trust's Jepson Prairie Preserve (Witham 2006). The Yolo County population was discovered by Bob Holland in 1993 on the eastern half of the Yolo Grasslands Park site. Colusa grass may have been more broadly distributed prior to conversion of Yolo County’s alkaline vernal pools and alkaline playas to rice fields and drainage ditches, but its rarity in playas in the Jepson Prairie area suggests that it may have been limited to just a few alkaline pools or alkaline playas at both sites.

Population Trends

Despite lack of formal status surveys, the information available suggests a declining trend for this species, however, population sized can vary widely from year to year (USFWS 2005). Occurrences of Colusa grass have also declined at the Davis Communications Annex (Environmental Science Associates 2005), as well as at the Arena Plains site at the Merced NWR (D. Woolington, pers. comm. 2006). Hogle (2002) visited 24 occurrences (57 percent of all extant occurrences) in 2001 and reported that five of the 24 occurrences (20 percent) were extirpated since the 1980s. The CNDDB (2007) indicated that five extant occurrences were declining, one as stable, and the status was reported as unknown for the remaining 36 extant occurrences.

The population at the Yolo Grasslands Park site is distributed in five small sub-basins and its population size has varied considerably among years making it difficult to detect a downward trend (Gerlach, 2008, Report to Betty Warne of Sacramento USFWS for permission to collect Colusa grass seed under USFWS permit TE177978-0). In drought years the species exists solely as a soil seed bank (Crampton 1959, 1976). Approximately forty thousand plants were observed at this site in 2004 (Environmental Science Associates 2005) and zero reproductive plants were observed in 2007 (J. Gerlach unpublished data). The population in Olcott Lake is also similarly variable (Witham 1999). Due to the alternation of hydrologic processes by the construction of Monticello Dam and the cultivation of most of the formerly suitable habitat in the County, it is unlikely that Colusa grass will ever occur at other sites in Yolo County, except at this location at Yolo Grasslands Park. Therefore, conservation of the known occupied habitat in this area is essential to conserve this species in Yolo County.

Threats to the Species and Other Conservation Issues

Immediate threats to Colusa grass in Yolo County are primarily due to the invasion of its habitat by swamp timothy and perennial pepperweed (*Lepidium latifolium*) (Environmental Science Associates 2005). There are no known effective management tools for reducing the impacts of swamp timothy but in 2007 Yolo County began a long term perennial pepperweed eradication program that has proved to be effective. Swamp timothy is a threat to San Joaquin populations (Stone 1988, Holland 2000, Hogle 2002). Interestingly, Crampton (1959, 1976) does not mention swamp timothy in either of his papers so its invasion of vernal pools may be a relatively recent phenomenon. Lippia (*Phylla nodiflora*), is an invasive threat to the Olcott Lake population (Witham 1999). The extensively altered hydrology of the Yolo County site may pose an additional long-term threat to this occurrence of the species.

Annual population sizes are sensitive to annual climatic variations. The environmental triggers and the biological traits that allow the species to respond to those triggers are unknown and need to be investigated. In particular, research should focus on the factors that control the timing of seed germination, seedling survival in highly turbid water, the impacts of swamp timothy, and the factors that control seed production and dispersal. Additionally, control methods for swamp timothy should be developed to reduce the impacts of this invasive species on Colusa grass.

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