FINAL REPORT

Botanical Resources Inventory At Calhoun Cut Ecological Reserve Following California's Recent Drought

Submitted by:

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Submitted to:

California Department of Fish and Game
Natural Heritage Division
1416 Ninth Street
Sacramento, California 95814-2090

Funded by:

Emergency Drought Relief Project
Contract No. CA HER 022894

August 15, 1994

WIT94R001

WIT94R

No EO info - we received fsp's separately. This report just gives bonus info. Xeroxed for files

f: Central Vlly Reg Files

blue line maps (possible map detail?)

381237

Aster lentus
Downingia pusilla
Lilaeopsis masonii
Lathyrus jepsonii
Limosella subulata
Vlly needlegrass grassland
N. Hardpan VP

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EXECUTIVE SUMMARY

The climate of the Central Valley of California is characterized by mild, wet winters and hot, dry summers. Consecutive winters of below average rainfall, such as during 1987-1992, intensify the effects of the annual summer drought. Perennial grassland plants and seasonal wetland plant communities might be particularly susceptible to winter rainfall shortages.

To help guide future management decisions on the Department of Fish and Game, Calhoun Cut Ecological Reserve (Solano County), a baseline study was conducted during 1994. The overall goals of the baseline study were threefold: i) classify and map vegetation types with emphasis on sensitive plant communities and those which may be susceptible to drought; ii) map distribution of native bunchgrass stands and assess the age (size) structure of native grasslands; and iii) verify and map rare plant occurrences plus identify and survey additional potential rare plant habitat.

The baseline data are presented on annotated 1"=400' (1:4800 scale) aerial photographs and on California Natural Diversity Data Base field survey forms. The maps, CNDDB forms and a compiled plant species list are included as appendices to this report. Overall results of this study include:

- Vegetation of the Calhoun Cut Ecological Reserve was classified into eleven distinct vegetation types in three primary groups: grasslands, marshes and riparian. Two-thirds of the site is occupied by grassland vegetation types. Within these grasslands, two sensitive plant communities occur: vernal pools and purple needlegrass (*Nassella pulchra*) grassland. Marshes and associated wetland plant communities occupy nearly one-third of the site. The riparian vegetation is limited to a narrow corridor along the dredged and leveed Calhoun Cut.

- The purple needlegrass grassland does not appear to be regenerating. All of the stands are within areas dominated by coarse annual grasses such as medusa head (*Taeniatherum caput-medusae*) and ripgut brome (*Bromus diandrus*). Accumulated annual grass biomass appears to prevent regeneration and may even threaten survival of adult bunchgrasses. The purple needlegrass stands were mapped according to four devised classifications based upon cover and area occupied.

- All previously reported occurrences of six species of rare plants were confirmed through field survey work. Dwarf downingia (*Downingia pusilla*) and legenere (*Legenere limosa*) occur in vernal marsh/vernal pool habitat just south of Calhoun Cut. Suisun Marsh aster (*Aster lentus*), delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), Mason's lilaeopsis (*Lilaeopsis masonii*) and delta mudwort (*Limosella subulata*) occur within the tidal zone along Calhoun Cut and Barker Slough. Many new occurrences of the tidal zone rare plants were located and mapped during the course of this project; combinations of these four species occur almost continuously along both banks of both sloughs.

To protect and enhance the vernal pools and native grassland plant communities, removal of annual grass biomass accumulation is recommended. Controlled burns and/or managed sheep grazing are two methods to be considered. Burning may be the most effective strategy for the control of medusa head and other unpalatable grasses. If grazing is considered as a primary or secondary management approach, the marshes and riparian zones should be protected through the use of temporary electric fencing.

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INTRODUCTION AND PROJECT OBJECTIVES

The Department of Fish and Game, Calhoun Cut Ecological Reserve is located approximately 12 miles south of Dixon in Solano County. A vicinity map is provided in Figure 1. The reserve occurs between the Jepson Prairie Preserve, an area of vernal pools and native grassland, and extensive tracts of reclaimed land in the Sacramento River delta. The Calhoun Cut parcel contains a unique mosaic of remnant delta marshes and valley grassland/vernal pool habitat. A topographic map of the parcel is provided in Figure 2.

The Central Valley of California has a climate characterized by mild, wet winters and hot, dry summers. Drought years may have insufficient winter precipitation to recharge the soil moisture to capacity. Several successive dry winters intensify the effects of the hot, dry summer season (Major 1988). Perennial grassland plants and seasonal wetland plant communities might be particularly susceptible to prolonged drought such as that of 1987-1992.

Since no baseline studies have been previously performed, a post-drought study was initiated on the Calhoun Cut Ecological Reserve in 1994. The overall objective of this project is to provide baseline information on rare plants and sensitive plant communities to help guide future land management decisions and activities. Specific tasks accomplished during the course of this study included:

- Classify and map vegetation types with particular emphasis on sensitive plant communities and those which may be susceptible to drought, such as riparian and wetland habitats.

- Develop a classification system for native bunchgrass stands based upon relative cover by native species, dominant species within each stand, and presence or absence of small (young) bunchgrasses. Map distribution of native grasses according to devised classification system.

- Verify all known occurrences of rare plants. Identify and field survey additional areas of potential rare plant habitat. Map distribution of rare plant occurrences.

In addition to providing baseline data, specific recommendations have been formulated for the protection, maintenance and enhancement of rare plant habitat and sensitive plant communities.

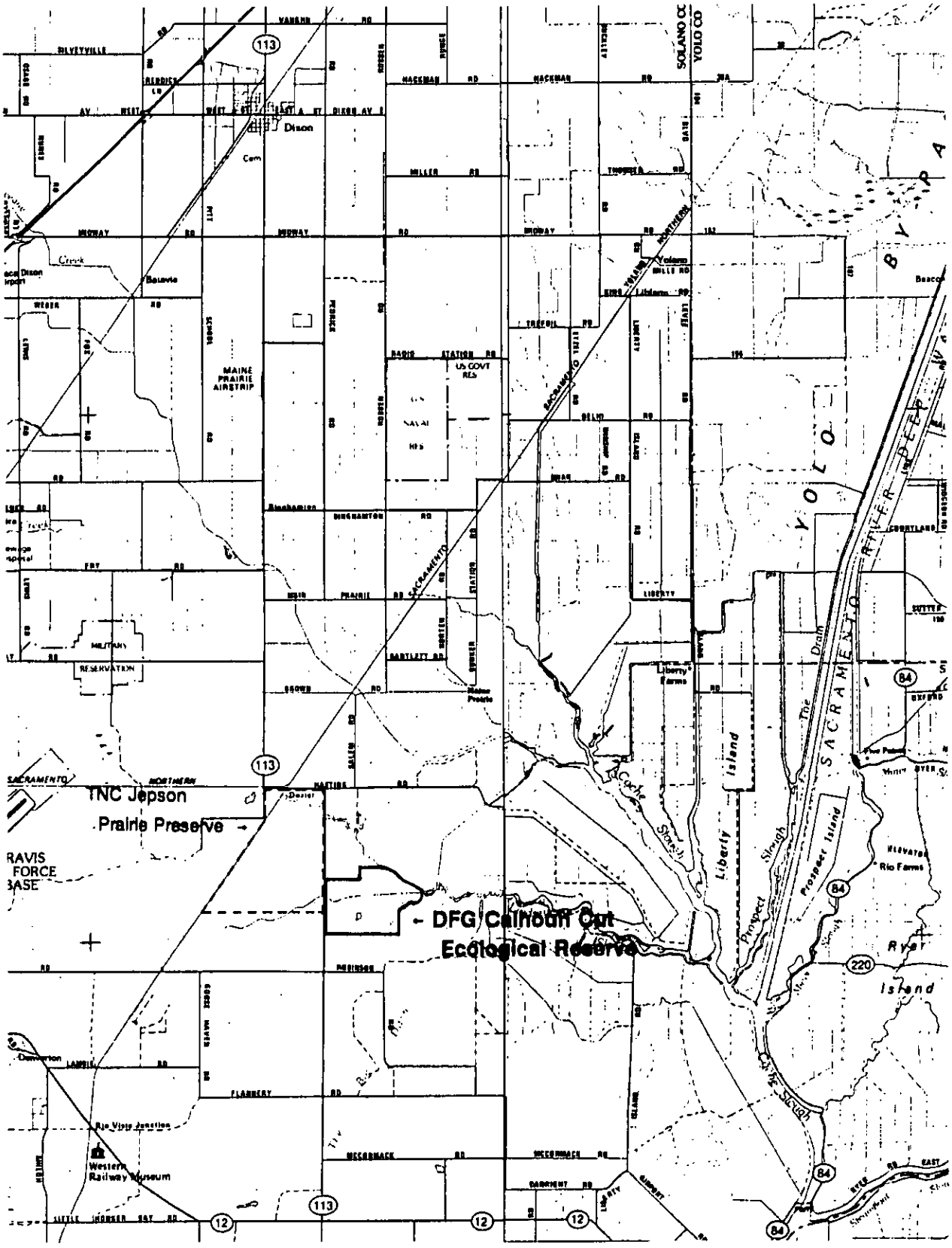

Figure 1: Department of Fish and Game, Calhoun Cut Ecological Reserve vicinity map. Note the Jepson Prairie Preserve to the west and the tracts of reclaimed land to the east.

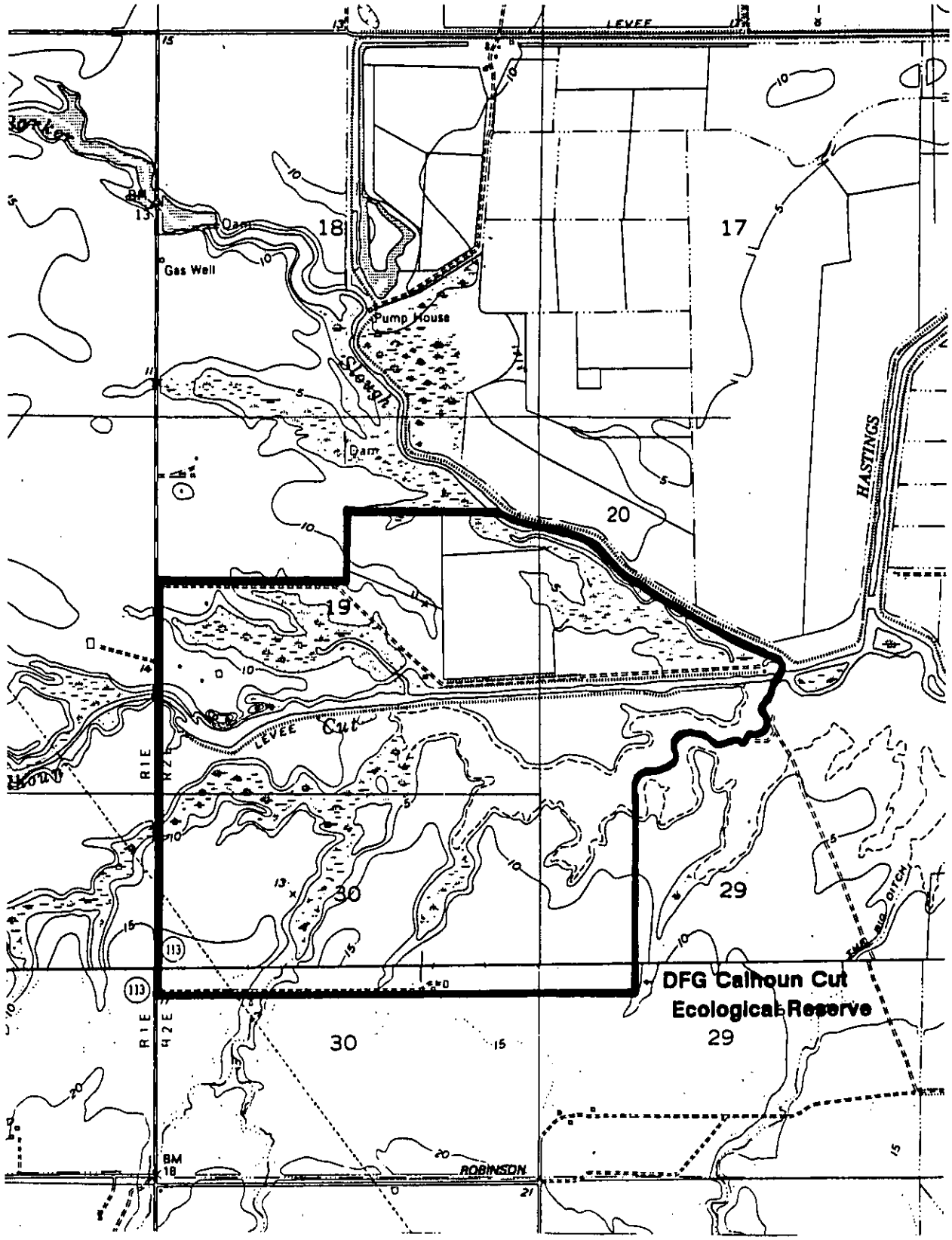

Figure 2: Topographic map of the Calhoun Cut Ecological Reserve. The fingers of marsh land are the historic Lindsey Slough bed. Scale 1:24000

METHODS AND MATERIALS

BACKGROUND AND LITERATURE REVIEW

Background information was gathered on the rare, threatened or endangered plants and special natural communities known to occur in the Calhoun Cut region of Solano County. Resources available included data on the known and historic locations of special-status plant species (NDDB 1994) and communities (Holland 1986) tracked by the Non-game Heritage Program of the Department of Fish and Game and the California Native Plant Society's *Inventory of Rare and Endangered Vascular Plants of California* (Skinner and Pavlik 1994). A draft version of the new *Series descriptions of California's vegetation* (Sawyer 1994) was also reviewed for pertinent information on plant community classifications.

Other resources consulted during the course of the field investigations and interpretation included *The Jepson Manual* (Hickman 1993), *A Flora of the Marshes of California* (Mason 1957), *A California Flora and Supplement* (Munz and Keck 1973), *Soil Survey of Solano County* (Bates 1977), *National List of Plant Species that occur in Wetlands* (Reed 1988), plus USGS 7.5' series topographic maps, aerial photography, a variety of reports on rare plant surveys conducted in the vicinity (i.e. Hawkins and Hrusa 1992), the extensive prior experience and local field observations of the botanical investigator, and consultation with other knowledgeable individuals.

CLASSIFICATION AND MAPPING OF VEGETATION TYPES

Two vegetation classification systems were considered for use on the Calhoun Cut Ecological Reserve: i) the Holland (1986) classification system, and ii) a draft of the new series description system by Sawyer (1994). Sensitive plant communities currently tracked by the Natural Diversity Data Base follow Holland. However, the California Native Plant Society's committee on natural communities proposes the Sawyer system for future use in the Natural Diversity Data Base. Following several reconnaissance level site visits, both of these vegetation classification systems were reviewed for appropriateness to the Calhoun Cut Ecological Reserve site.

The Holland system is based upon a list of habitat types originally developed by Cheatham and Haller (1975). This list of descriptive names has undergone several revisions with the most recent (Holland 1986) containing brief descriptions of each plant community. Generally the descriptions are based on overall aspect, abiotic factors and a short list of characteristic species. This classification system has the advantage of familiar nomenclature and current usage. A drawback of the Holland system is that it often lumps highly variable vegetation types into single plant communities.

The new Sawyer system consists of vegetation *series* based upon the genus of the dominant plant species within the highest strata of the vegetation. No hierarchical arrangements broader than series have been proposed. Narrower hierarchical categories would consist of *stands* of a dominant species and all the associate species within the sampling site. This system will eventually provide highly quantitative descriptions of California's rare plant communities which will aid in their legal protection. However, this classification system is still in draft form and it is far too detailed to be of much use in general resource management.

The vegetation classification system chosen to characterize and map the plant communities of the Calhoun Cut Ecological Reserve generally follows Holland (1986) with some minor revisions and additions. The marsh communities have been refined to reflect dominant or important species and abandoned agricultural land has been added. The vegetation type units used in mapping the Calhoun Cut Ecological Reserve are listed in Table 1 (page 7). Reference to both Holland and Sawyer types, plus a brief description of each is also provided in the table.

NATIVE GRASSLAND CLASSIFICATION AND MAPPING

Prior to developing a classification system for the native perennial bunchgrasses on the Calhoun Cut Ecological Reserve, an intensive survey of the entire parcel was conducted. The field survey method used walking transects which were approximately parallel and spaced to allow an overlapping area of visual inspection. Along each transect, pin flags were placed at the beginning and end of native bunchgrass areas encountered. This technique provides line-of-site perimeter flagging of each grassland facilitating accurate mapping of the spacial extent of each unit.

For each mapped unit of native grassland, data were collected on the relative cover of each species of native bunchgrass, dominant and associate plant species within the stand, and the presence or absence of small (young) bunchgrasses. Relative cover of native grasses was determined by ocular estimates. These data were used to develop a classification system for stands of native bunchgrasses on the Calhoun Cut Ecological Reserve.

RARE PLANT SURVEY AND MAPPING

A table of special-status plants potentially occurring on the Calhoun Cut Ecological Reserve was compiled and is provided in Table 2 (page 13). The flowering time and habitat requirement of each special-status plant species were reviewed prior to the field survey. All potential habitat was surveyed in detail. All open water and upland edges of dense tule stands were thoroughly surveyed; interior areas were scanned with binoculars and subsampled where appropriate. Similarly, dense thickets of rose and sandbar willow were carefully surveyed along their perimeter and scanned with binoculars. For each rare plant population encountered, sufficient data were collected to characterize the population size, plant phenology and associate species.

SURVEY RESULTS

The primary results of this project are presented on maps and in technical appendices to the report. Three sets of maps (vegetation maps, native grassland maps, and rare plant maps) are provided in the map pockets inside the back cover. Documentation of sensitive plant communities is provided in Appendix III. Documentation of rare plant occurrences is provided in Appendix II. Additionally, a list of plant species observed during the course of the field investigation was compiled and is provided as Appendix IV.

VEGETATION CLASSIFICATION AND MAPPING

Vegetation types were mapped according to a slightly modified version of the Holland (1986) classification system. Table 1 provides a summary of the vegetation types encountered. The table also provides mapping unit abbreviations, comparison with Holland and Sawyer classification systems, and a brief description of the plant community. We have expanded the marsh communities to reflect ecologically important variation in dominant species. We have also included an abandoned agricultural grassland vegetation type. A more thorough description of each vegetation type, as it occurs on the Calhoun Cut Ecological Reserve, is provided below. Maps 1A-1C are 1:4800 scale aerial photographs with boundaries between vegetation types depicted by lines. Each mapped polygon is annotated with an abbreviation for the plant community represented.

Grassland and Associated Plant Communities

Approximately two-thirds of the Calhoun Cut Ecological Reserve is occupied by annual grassland and associated plant communities such as abandoned agricultural land, needlegrass grassland, wildrye grassland, and vernal pools. All of the grassland plant communities contain more than 10% cover in medusa head (*Taeniatherum capus-medusa*).

Annual Grassland (map unit AG) is the predominant vegetation unit on the Calhoun Cut Ecological Reserve. The annual grasslands exhibit some variation in composition due to edaphic, topographic and hydrologic factors. The annual grassland is generally dominated or codominated by introduced exotic grasses such as medusa head (*Taeniatherum caput-medusae*), ripgut brome (*Bromus diandrus*), wild oats (*Avena fatua*) and occasionally hare barley (*Hordeum murinum* ssp. *leporinum*). Non-native forbs such as filaree (*Erodium botrys*) and prickly lettuce (*Lactuca serriola*) may also have significant cover. Most of the areas mapped as annual grassland contain 20-50% relative cover in medusa head (*Taeniatherum caput-medusae*).

On the deeper soils, the coarse grasses and forbs have produced a significant amount of biomass. This accumulation of plant material, particularly medusa head thatch, appears to be obstructing germination or establishment of native species, including perennial bunchgrasses. In some areas with shallower soils codominants may include soft chess (*Bromus marinum* ssp. *gussoneum*) growing in association with native annuals such as California plantain (*Plantago erecta*). More mesic intermound areas are often dominated by Italian ryegrass (*Lolium multiflorum*) growing in association with California coyote thistle (*Eryngium aristulatum*) and elegant brodiaea (*Brodiaea elegans*). These ryegrass swales are often an intergrade between the annual grassland and vernal pools.

Table 1: Vegetation types used to map the Calhoun Cut Ecological Reserve including reference to Holland type and newly proposed series descriptions. Additional descriptive information on each vegetation type may be found in the Results section of the report. Map units refer to Vegetation Maps (Maps 1A-1C).

Map Unit	Vegetation Type Name	Holland Classification (Holland 1986)	Series Description (Sawyer 1994)	Description of Vegetation Type on Calhoun Cut Ecological Reserve
GRASSLANDS AND ASSOCIATED PLANT COMMUNITIES				
AG	Annual Grassland	Non-native Grassland (42200)	California annual grassland series	Grassland dominated by annual *Bromus*, *Hordeum*, *Avena*, and forbs; perennial grasses may be present.
AA	Abandoned Agricultural	Non-native Grassland (42200)	California annual grassland series	Levelled and diked area dominated by non-native annual grasses and forbs.
VP	Vernal Pools	Northern Claypan Vernal Pool (44120)	Northern claypan vernal pool habitat	Seasonal wetlands dominated by herbs in the genera: *Allocarya*, *Psilocarphus*, *Lasthenia* and *Eryngium*.
NG	Needlegrass Grassland	Valley Needlegrass Grassland (42110)	Purple Needlegrass series	Grassland in which *Nassella pulchra* is an important species.
WG	Wildrye Grassland	Valley Wildrye Grassland (42410)	Creeping Ryegrass series	Grassland dominated by *Leymus triticoides*.
MARSHES AND ASSOCIATED WETLANDS				
TM	Tule Marsh	Coastal and Valley Freshwater Marsh (52410); Cismontane Alkali Marsh (52310)	Bulrush series	Emergent marsh dominated by near monoculture stands of *Scirpus acutus*.
CM	Cattail-Bulrush Marsh	Cismontane Alkali Marsh (52310)	Bulrush-Cattail series; Pondweeds with submerged leaves series	Emergent seasonal marsh in which *Scirpus* and *Typha* are important, but not dominant.
OW	Open Water	Coastal and Valley Freshwater Marsh (52410)	Mosquito Fern series	Areas of ponded, open water within the tule marshes.

Table 1: Vegetation types used to map the Calhoun Cut Ecological Reserve (continued).

Map Unit	Vegetation Type Name	Holland Classification (Holland 1986)	Series Description (Sawyer 1994)	Description of Vegetation Type on Calhoun Cut Ecological Reserve
MARSHES AND ASSOCIATED WETLANDS (continued)				
VM	Vernal (Alkali) Marsh	Cismontane Alkali Marsh (52310); Vernal Marsh (52500)	Saltgrass series; Sedge series; Spikerush series; Creeping Ryegrass series	Seasonal wetland between emergent marsh vegetation and grassland; *Distichlis spicata* is important along with several other species which occur as dominants or codominants.
RIPARIAN CORRIDOR PLANT COMMUNITIES				
WS	Willow Scrub	Great Valley Willow Scrub (63410)	Mixed Willow series	Narrow band of woody/shrubby riparian vegetation along Calhoun Cut; *Salix*, *Rosa* and *Alnus* are dominants; oaks and cottonwoods occasional.
TF	Tidal Flat	Coastal and Valley Freshwater Marsh (52410)		Mudflats along Calhoun Cut within the tidal zone; *Lilaeopsis* and *Hydrocotyle* may be important; *Scirpus* occasionally dominant.

Abandoned Agricultural (map unit AA) land occurs on approximately 120 acres in the northeast corner of the parcel. This land was once levelled and diked to create a series of irrigated pastures. The pastures were most likely planted in ryegrass (*Lolium* spp.), wildrye (*Leymus triticoides*) and trefoil (*Lotus corniculatus*) which continue to be important components of the plant community. Generally the abandoned pastures are dominated by ryegrass, ripgut brome (*Bromus diandrus*) and prickly lettuce (*Lactuca serriola*). This area has been mapped as a separate unit since the levelled land may require different management strategies. One additional observation is that this area has a lower overall cover of medusa head (*Taeniatherum caput-medusa*) than any other grassland on the parcel.

Vernal Pools (map unit *VP*) and vernal pool complexes on the Calhoun Cut site are generally restricted to the southeast corner of the parcel. This is the only area of the parcel in which the San Ysidro-Antioch soil complex occurs. This soil complex is characterized by significant mima mound microtopography and an impermeable claypan. The deeper, better drained San Ysidro soils occur on the mound tops and support purple needlegrass (*Nasella pulchra*). The shallow and poorly drained Antioch Soils occur between the mounds and support ryegrass swales and vernal pools. Due to the photography scale (1:4800), most of the mapped polygons depict vernal pool complexes rather than individual pools.

The claypan vernal pools are generally codominated by one or more of the following typical vernal pool species: Fremont's goldfields (*Lasthenia fremontii*), alkali goldfields (*Lastheniaplatycarpha*), prostrate popcornflower (*Plagiobothrys leptoclada*), small-flowered allocarya (*Plagiobothrys stipitatus* var. *micranthus*), wooly marbles (*Psilocarphus brevissimus*), coyote thistle (*Eryngium* spp.), downingia (*Downingia* spp.), annual hairgrass (*Deschampsiadanthonioides*), and California semaphore grass (*Pleuropogon californicus*). Some small, hydrologically isolated fingers of the historic Lindsey Slough bed are mapped as vernal marshes, but also contain a significant diversity of typical vernal pool species.

Needlegrass Grassland (map unit *NG*), for the purposes of vegetation mapping, is defined as areas within the annual grassland which have significant cover (>10%) in purple needlegrass (*Nassella pulchra*). No other native grasslands were found to occur on the site. In addition to including Needlegrass Grassland on the plant community maps, this habitat is also depicted on a separate set of maps (Maps 2A-2C) that subdivide needlegrass occurrences into units based on cover (as discussed on Page 11).

Wildrye Grassland (map unit *WG*) are small areas within the annual grassland dominated by near monoculture stands of the rhizomatous creeping wildrye (*Leymus triticoides*). This species is also a common component of the vernal alkali marsh vegetation type where it is not mapped as a separate polygon.

Marshes and Associated Wetland Communities

Approximately one-third of the Calhoun Cut Ecological Reserve is occupied by marshes and associated plant communities. All of the historic Lindsey Slough bed, including some dredged and leveed areas of Barker Slough and Calhoun Cut, is dominated by marsh vegetation.

Tule Marsh (map unit TM) is the most extensive wetland vegetation type on the Calhoun Cut Ecological Reserve. This plant community occupies a majority of the historic Lindsey Slough bed where it occurs in seasonally flooded, tidal zone and permanently flooded areas. The tule marsh vegetation type is dominated by common tule (*Scirpus acutus*) which generally forms dense, monoculture stands. Other plant species are only common along the ecotones between the tule marsh and adjacent plant communities. On the open water edge of the tule marsh, associate species include yellow waterweed (*Ludwigia peploides*), knotweeds (*Polygonum* spp.) and mosquito fern (*Azolla filiculoides*). On the upland edge of the marsh, associate species often include California rose (*Rosa california*), fireweeds (*Epilobium* spp.), blue vervain (*Verbena hastata*), and hoary nettle (*Urtica dioica* var. *holosericea*). Occasionally, clumps of narrow-leaf cattail (*Typha angustifolia*), broad-leaf cattail (*Typha latifolia*), Olney's bulrush (*Scirpus americanus*), saltmarsh bulrush (*Scirpus maritimus*) and willows (*Salix* spp.) occur within the tule stands.

Open Water (map unit OW) occurs year round in some small areas within the tule marshes. These are generally located near flap gates and receive a fresh influx of water each high tide. The dominant plant species occurring in these areas of open water are yellow waterweed (*Ludwigia peploides*) and mosquito fern (*Azolla filiculoides*). The permanent open water was mapped as a separate unit as maintenance of this waterfowl habitat may require different management strategies.

Cattail-Bulrush Marsh (map unit CM) is an open area containing scattered clumps of emergent marsh vegetation such as saltmarsh bulrush (*Scripus maritimus*), Olney's bulrush (*Scripus americanus*), tule (*Scirpus acutus*) and narrow-leaf cattail (*Typha latifolia*). During the wet winter months, this marsh is predominantly open water containing sago pondweed (*Potamogeton pectinatus*), horned pondweed (*Zannichellia palustris*), and water buttercup (*Ranunculus aquatilis* var. *capillaceus*). During the summer months, prickle grass (*Crypsis vaginiflora*), swampgrass (*Crypsis schoenoides*) and annual goosefoot (*Chenopodium* spp.) cover the dry soils. This seasonal marsh was mapped separately since maintenance of waterfowl habitat may require different management strategies.

Vernal (Alkali) Marsh (map unit VM) occupies a zone between the emergent marshes and the grasslands. This plant community generally occurs as a narrow ribbon along the edge of the tule marshes. The area is inundated or saturated for portions of the year due to ponding of rainfall runoff, but is generally well above summer high tide levels. This area tends to be highly alkaline and often contains areas of bare alkali soils.

The vernal alkali marsh on the Calhoun Cut Ecological Reserve contains a mosaic of plants and plant associations. Saltgrass (*Distichlis spicata*) is ubiquitous, and often dominant. In the drier zones, alkali heath (*Frankenia salina*) is codominant and associates include sea-blite (*Suaeda* spp.), California coyote-thistle (*Eryngium aristulatum*), sandspurry (*Spergularia* spp.), and alkali goldfields (*Lasthenia platycarpha*). In the wetter areas, codominants can include clustered field sedge (*Carex praegracilis*), baltic rush (*Juncus balticus*), pale spikerush (*Eleocharis macrostachya*), creeping wildrye (*Leymus triticoides*), and yerba mansa (*Anemopsis californica*).

Several small fingers of the historic Lindsey Slough bed have been hydrologically isolated and contain a plant community between a vernal marsh and a vernal pool. These areas do not support emergent vegetation and are generally codominated by pale spikerush

(*Eleocharis macrostachya*) and saltgrass (*Distichlis spicata*). These areas also contain annual species most often associated with vernal pools such as downingia (*Downingia* spp.) and goldfields (*Lasthenia* spp.).

Riparian Corridor Plant Communities

Plant communities along the immediate edges of streams, or in this case sloughs, have less alkaline water and are subject more varied water level as a result of tidal influences. Plant communities occurring within the leveed portions of both Calhoun Cut and Barker Slough can be considered riparian.

Willow Scrub (map unit WS) occurs in a narrow band along both sides of the realigned portion of Calhoun Cut. Shrubby riparian vegetation also occurs on a small floodplain area at the junction of Calhoun Cut, Barker Slough and Lindsey Slough. The willow scrub vegetation type is dominated by tree and shrub willows (*Salix* spp.), California rose (*Rosa californica*) and white alder (*Alnus rhombifolia*). American dogwood (*Cornus sericea* ssp. *sericea*), Fremont's cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*) and California black walnut (*Juglans californica* var. *hindsii*) occur occasionally along with California grape (*Vitis californica*). Although riparian trees are a component of this plant community, the overstory is sporadic and does not warrant classification as a Riparian Forest or Riparian Woodland.

Tule Marsh (map unit TM) dominated by common tule (*Scripus acutus*), as described above, also occurs along the edges of dredged and leveed parts of both Calhoun Cut and Barker Slough. Occasionally, the rare Mason's lilaeopsis (*Lilaeopsis masonii*), delta mudwort (*Limosella subulata*) or Suisun Marsh aster (*Aster lentus*) occur along the edges of these tidal flat tule marshes.

Tidal Flats (map unit TF) occur within the tidal zone along both sides of Calhoun Cut near Highway 113. These areas generally consist of clayey or silty soils which are exposed at each low tide. Most of the tidal flats contain little or no vegetation; however, in some areas, these flats are important habitat for tidal zone rare plants such as Mason's lilaeopsis (*Lilaeopsis masonii*) and delta mudwort (*Limosella subulata*). Suisun Marsh aster (*Aster lentus*) is also known to occur on these tidal flats. These areas have been mapped as a separate units as maintenance of this important rare plant habitat may require different management strategies.

NEEDLEGRASS GRASSLAND MAPPING AND CLASSIFICATION

Prior to developing a classification system for the native perennial bunchgrasses on the Calhoun Cut Ecological Reserve, an intensive survey of the entire parcel was conducted. The field survey method used walking transects which were approximately parallel and spaced to allow an overlapping area of visual inspection. Along each transect, pin flags were placed at the beginning and end of native bunchgrass areas encountered. This technique provides line-of-site perimeter flagging of each grassland occurrence which facilitated accurate mapping of the spacial extent of each unit. For each mapped unit of native grassland, data were collected on the relative cover (by ocular estimate) of each species of native bunchgrass, dominant and associate plant species within the stand, and the presence or absence of small (young)

bunchgrasses. Review of these data was used to develop a simple classification system for stands of native bunchgrasses on the Calhoun Cut Ecological Reserve.

The results of the field survey were somewhat disappointing from a diversity perspective. Purple needlegrass (*Nassella pulchra*) was the only native perennial bunchgrass found to occur on the site. Within the needlegrass stands, evidence of reproductive success, in the form of small (young) plants, was virtually nonexistent. In all needlegrass stands, the same suite of coarse, annual grass species were dominant or codominant. The annual grasses most often associated with the purple needlegrass include medusa head (*Taeniatherum caput-medusae*), ripgut brome (*Bromus diandrus*) and wild oats (*Avena fatua*). The accumulated biomass generated by these annuals appears to be preventing the successful germination or establishment of new purple needlegrass plants.

On the positive side, there are extensive areas containing mature purple needlegrass (*Nassella pulchra*) plants. Based upon relative cover and spacial extent of purple needlegrass, the stands have been mapped according to one of four classification units: small cluster (5-20 plants), small stand (20-50 plants), low cover (<10%) grassland, and high cover (10-25%) grassland. The Native Grassland Maps (Maps 2A-2C) depict the location and extent of each of the four purple needlegrass classification units.

RARE PLANT OCCURRENCES

Six special-status plant species were found occurring on the Calhoun Cut Ecological Reserve during the May-July survey period: Suisun Marsh aster (*Aster lentus*), dwarf downingia (*Downingia pusilla*), delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), legenere (*Legenere limosa*), Mason's lilaeopsis (*Lilaeopsis masonii*) and delta mudwort (*Limosella subulata*). All of these plants occur in wetland habitats. Dwarf downingia and legenere occur in vernal pools and vernal marshes. Suisun Marsh aster, delta tule pea, Mason's lilaeopsis and delta mudwort occur in tidal zones and marshes along rivers and streams in the Central Valley.

Each rare plant occurrence is depicted on the Rare Plants Map (Maps 3A-3C). Although the maps are intended to show both location and size of each population, the spacial extent of small occurrences have been exaggerated for the purposes of mapping. California Native Species Field Survey forms have been completed for each occurrence and are provided as Appendix II. Below is a brief discussion of habitat requirements, extent and distribution of each special-status plant species.

Suisun Marsh Aster (*Aster lentus*)

Suisun Marsh aster is a rather large, showy perennial in the Asteraceae (sunflower) family. It is endemic to marshes along tidal streams in the Sacramento-San Joaquin delta. Suisun Marsh aster is distinguished from similar species by both its wetland habitat and lack of hairiness. Although rather large and showy, Suisun Marsh aster can be difficult to detect in the tangle of other streamside plants with which it grows.

A single large occurrence (EO #28) of Suisun Marsh aster was previously reported along Barker Slough and Lindsey Slough (NDDB 1994). The portion of this occurrence located on the Calhoun Cut Ecological Reserve has been remapped as several smaller polygons. Additionally, many new occurrences were located and mapped along Calhoun Cut during the course of this

Table 2: Special-status plant species with potential to occur in the Calhoun Cut region of Solano County.

Common name *Scientific Name*	Special Status[a]	Habitat	Survey Period	Calhoun Cut[b]
Suisun Marsh aster *Aster lentus*	1b,C2	marshes	summer	present
alkali milk-vetch *Astragalus tener* var. *tener*	1b	grassland/ vernal pools	early spring	possible
brittlescale *Atriplex depressa*	1b	alkaline grassland	summer	not found
San Joaquin spearscale *Atriplex joaquiniana*	1b,C2	alkaline grassland	summer	not found
dwarf downingia *Downingia pusilla*	2,C3c	vernal pools	early spring	present
fragrant fritillary *Fritillaria liliacea*	1b,C2	grassland	early spring	unlikely
Bogg's Lake hedge-hyssop *Gratiola heterosepala*	CE,1b,C3	vernal pools	spring	unlikely
California hibiscus *Hibiscus lasiocarpus*	2	marshes	summer	not found
Carquinez goldenbush *Isocoma arguta*	1b,C2	alkaline grassland	summer	not found
delta tule pea *Lathyrus jepsonii* var. *jepsonii*	1b,C2	marshes	late spring	present
legenere *Legenere limosa*	1b,C2	vernal pools	early spring	present
Mason's lilaeopsis *Lilaeopsis masonii*	CR,1b,C2	marshes	summer	present
delta mudwort *Limosella subulata*	2	marshes	summer	present

[a] Special-status designations:
- CE = State listed, endangered.
- CR = State listed, rare.
- C2 = Candidate for federal listing with insufficient data to support listing.
- C3 = Too widespread and/or not threatened to support candidacy for federal listing.
- 1b = Considered "rare, threatened or endangered" by the California Native Plant Society (Smith and Berg, 1988).
- 2 = Considered "rare, threatened or endangered in California, but more common elsewhere" by the California Native Plant Society.

[b] Based upon field survey and habitat assessment conducted during the period of May 4 through July 14, 1994.

survey. Suisun Marsh aster generally occurs in the upper tidal zone, above erosional cuts in the levee banks, along Calhoun Cut, Barker Slough and Lindsey Slough. Most of the individual occurrences are small; many may be single plants with one to several main stems. A significant proportion of the plants occur in relatively shaded areas either along north-facing banks or under overhanging trees. One population mapped along the northern finger of the historic Lindsey Slough bed, plus some of the streamside plants examined, have pubescent upper stems and may be an intergrade with *A. chilensis* which is known to occur in nearby alkali areas.

Suisun Marsh aster is the least common of the four streamside rare plants found on the Calhoun Cut Ecological Reserve. As such, it is often found growing near occurrences of delta tule pea (*Lathyrus jepsonii* var. *jepsonii*) which occupies a slightly drier habitat, plus Mason's lilaeopsis (*Lilaeopsis masonii*) and delta mudwort (*Limosella subulata*) which occupy wetter areas. No associate plants were noted as common for all occurrences of Suisun Marsh aster. However, we observed that each of the larger populations of Suisun Marsh aster appeared to have a resident population of *Phyciodes campestris*. Both *Aster lentus* and *Aster chilensis* are known local host plants for this butterfly; the larvae eat the leaves of the aster.

Dwarf Downingia (*Downingia pusilla*)

Dwarf downingia is a diminutive annual in the Campanulaceae (bellflower) family. The plant is restricted to vernally mesic habitats such as vernal pools, vernal marshes and wet meadows in the Central Valley (plus similar habitat in Chile). Dwarf downingia is locally abundant on the adjacent Jepson Prairie Preserve of The Nature Conservancy where it occurs in relatively shallow vernal pools and along compacted sheep trails in moist grassland areas (Witham 1992). Generally, this plant is observed in areas of low competition and low cover. Dwarf downingia is most easily detected when flowering in late-March and early-April. When in seed, it is difficult to distinguish from the several cogeners occurring in the same habitat.

Due to an unusually early vernal pool season, it was only possible to confirm one of the two known occurrences (NDDB 1994) of dwarf downingia on the Calhoun Cut Ecological Reserve during the May-July survey. This occurrence (OE #45) is in a small vernal marsh near Highway 113 and south of Calhoun Cut. The vernal marsh is a small finger of the historic Lindsey Slough which has been hydrologically isolated from the balance of the system. The vernal marsh is dominated by pale spikerush (*Eleocharis macrostachya*) and saltgrass (*Distichlis spicata*). In addition to the dwarf downingia, other species more typical of vernal pools also occur here, including legenere (*Legenere limosa*), flat-face downingia (*Downingia pulchella*) and coast popcornflower (*Plagiobothrys undulatus*). Within this habitat, the dwarf downingia occurs along the shallow margins of the basin.

The second known occurrence (EO #34) was reported from another hydrologically isolated vernal marsh area south of Calhoun Cut and approximately ½ mile east of Highway 113 (NDDB 1994). At the time of the field survey, it was not possible to positively determine the presence of dwarf downingia. However, the habitat is intact and appears to be highly suitable for the species. This occurrence has been included on the Rare Plants Maps.

In the southeast corner of the parcel (SW¼ of NW¼ of Section 29 and SE¼ of NE¼ of Section 30) are several clusters of vernal pools and vernal swales with the potential to support dwarf downingia. This species is known to occupy very similar habitat on the adjacent Jepson Prairie parcel (Witham 1992). Due to the early blooming season and the lateness of this survey, it was

not possible to determine presence or absence of dwarf downingia in these vernal pools. It is recommended that the area be resurveyed next spring.

Delta Tule Pea (*Lathyrus jepsonii* var. *jepsonii*)

Delta tule pea is an herbaceous, perennial vine in the Fabaceae (Pea) family. This species is endemic to marshes and tidal streams in the Sacramento-San Joaquin Delta. Delta tule pea is distinguished from similar species by both it broadly winged stems and its lack of hairiness. This species often grows in tangled masses within and above other streamside vegetation. With its showy clusters of flowers and distinctive blue-grey leaf color, delta tule pea is easily distinguished from the vegetation within which it grows.

A large known occurrence occurrence (EO #52) was reported as ten colonies and is mapped as four polygons along Barker Slough and Lindsey Slough (NDDB 1994). The portion of this occurrence located on the Calhoun Cut Ecological Reserve has been remapped as several smaller polygons. Additionally, numerous new populations were located and mapped along Calhoun Cut during the course of this survey. Generally, this plant occurs within the upper tidal zone and amongst shrubby vegetation. The most common associate plant is California rose (*Rosa californica*) with the pea growing within and above the dense rose thickets. Occasionally, delta tule pea was also found growing in association with sandbar willow (*Salix exigua*). No occurrences were found within or along the edges of the tule marshes.

During the course of field work, we made two significant observations on the ecology of this species. First, each occurrence appears to have a resident population of *Everes comyntas*; the larvae of this butterfly eat the flowers and seedpods of the delta tule pea. Second, many of the flowering stems wilted and died prior to setting seed; the stems appeared to have been completely eaten near the ground, perhaps by rodents.

Legenere (*Legenere limosa*)

Legenere is a small annual in the Campanulaceae (bellflower) family. This plant is restricted to vernally mesic habitats such as vernal pools and vernal marshes in the Central Valley. Legenere is locally abundant on the adjacent Jepson Prairie Preserve of The Nature Conservancy where it occurs in the larger vernal pools (Witham 1992). This plant is most often found in association with pale spikerush (*Eleocharis macrostachya*) and smooth goldfields (*Lasthenia glaberrima*). The fruiting legenere is easily distinguished from the related *Downingia* by the presence of a pedicel below the elongated inferior ovary.

The single known occurrence (EO #1) of legenere on the Calhoun Cut Ecological Reserve (NDDB 1994) was confirmed during this survey. The population is occurring in a vernal marsh just east of Highway 113 and south of Calhoun Cut. The vernal marsh is a hydrologically isolated finger of the historic Lindsey Slough bed. The dominant species are pale spikerush (*Eleocharis macrostachya*) and saltgrass (*Distichlis spicata*) with many vernal pool plants also occurring within the vernal marsh. The legenere grows in the lowest and wettest areas of the depression.

During the course of this survey we noted that this population of legenere consists entirely of plants with corollas. Personal observations of the occurrences on the adjacent Jepson Prairie parcel indicate that those populations are apetalus and, therefore, cleistogamous. The Calhoun Cut population also blooms a little later in the season that most of the Jepson Prairie populations. No pollinators were observed during the course of this survey.

No other suitable habitat for legenere was observed on the Calhoun Cut parcel. The other vernal marshes and all of the vernal pools appear to have too short a period of inundation to support this species. None of these other depressions supported populations of pale spikerush (*Eleocharis macrostachya*) and smooth goldfields (*Lasthenia glaberrima*) which are known associates of legenere.

Mason's lilaeopsis (*Lilaeopsis masonii*)

Mason's lilaeopsis is a tiny, rhizomatous perennial in the Apiaceae (carrot) family. It is endemic to the tidal zone of rivers and streams in the Sacramento-San Joaquin delta (plus along the Napa River). Given its preference for low tidal flats on clayey or silty soils, this species is easy to locate during low tide. When not blooming, the plant is distinguished from delta mudwort (*Limosella subulata*) by the somewhat obscure septae (partitions) in the cylindrical leaves (actually modified petioles). However, since these plants often grow together in densely-tufted carpets, this characteristic is not easily observed. Distinction between the two is best made when one or both are in flower or fruit.

Currently, the Natural Diversity Data Base occurrence (EO #70) of Mason's lilaeopsis on the Calhoun Cut Ecological Reserve is mapped as a somewhat continuous band along Barker Slough, Calhoun Cut and Lindsey Slough (NDDB 1994). This is an fairly accurate depiction of the spacial extent of this species on the site; only slight remapping has been done as a result of this field survey. Mason's lilaeopsis occurs in two distinctive microhabitats within the tidal zone of the sloughs. It usually occupies the outer several inches of the erosion cutbanks along the sloughs. In these microsites, Mason's lilaeopsis grows in association with many other streamside species. Additionally, it is often found growing in patches, below the cutbanks, on flat areas of clayey or silty soils. The second occurrence type is the most easily observed; only marsh pennywort (*Hydrocotyle verticillata*), annual bulrush (*Scirpus cernuus*) and delta mudwort (*Limosella subulata*) also occur in these microsites.

No Mason's lilaeopsis was found outside the streamside tidal zone. The marshes behind flapgates in the historic Lindsey Slough bed may have insufficient tidal influence to support this species. Alternatively, the soils and water may be too alkaline for Mason's lilaeopsis.

Delta Mudwort (*Limosella subulata*)

Delta mudwort is a tiny, rhizomatous perennial in the Scrophulariaceae (figwort) family. It occurs in tidal areas in the Sacramento-San Joaquin delta as well as in similar habitat on the east coast. On initial inspection, this plant can be easily mistaken for the more common Mason's lilaeopsis (*Lilaeopsis masonii*) with which is usually occurs. However, the tiny bell-shaped flowers are quite distinctive and easily seen on closer inspection.

On the Calhoun Cut Ecological Reserve two occurrences have been previously reported (NDDB 1994). One is along Calhoun Cut near Highway 113 (OE #6) while the other is along Barker Slough (OE #4). In addition to confirming these occurrences, many additional sites were recorded and mapped during the course of this study. Delta mudwort appears to occur in most of the low tidal flat occurrences of Mason's lilaeopsis (*Lilaeopsis masonii*). However, it was not observed as commonly occurring within the Mason's lilaeopsis growing along the outer edges of cutbanks. Where found, the delta mudwort appeared to be in very low proportion ($\pm$ 10%) compared to the Mason's lilaeopsis. Other species growing in association with the delta mudwort

include Mason's lilaeopsis marsh pennywort (*Hydrocotyle verticillata*) and annual bulrush (*Scirpus cernuus*).

No delta mudwort was found outside the streamside tidal zone. The marshes behind flapgates in the historic Lindsey Slough bed may have insufficient tidal influence to support this species. Alternatively the soils and water may be too alkaline for delta mudwort.

Additional Survey Work Needed

As mentioned above this survey was conducted too late to identify certain early spring vernal pool species. In particular two species seem likely candidates for additional occurrences on the Calhoun Cut Ecological Reserve: alkali milk-vetch (*Astragalus tener* var. *tener*) and dwarf downingia (*Downingia pusilla*). The appropriate survey period for both species is generally from mid-March to mid-April. Both species occur in vernal pools and the southeast corner of the parcel should be resurveyed. Additionally alkali milk-vetch is known from alkaline vernal marshes on adjacent parcels and the outer fingers of the historic Lindsey Slough bed should be resurveyed for this species.

The survey period was also too late to detect two other early spring species: fragrant fritillary (*Fritillaria liliacea*) and Boggs Lake hedge-hyssop (*Gratiola heterosepala*). Both of these species occur on the adjacent Jepson Prairie parcel (Witham 1992). Fragrant fritillary occurs in the deeper mima mound soils often in association with purple needlegrass (*Nassella pulchra*). Boggs Lake hedge-hyssop is known from larger vernal pools. Potential habitat for both species occurs on the Calhoun Cut Ecological Reserve. However based on the professional opinion of the botanical investigator it is highly unlikely that either species occurs here.

DISCUSSION OF FINDINGS

VEGETATION TYPES, INCLUDING NATIVE GRASSLAND

The plant associations of the Calhoun Cut Ecological Reserve were classified into eleven distinct vegetation types in three primary groups: grasslands, marshes and riparian. A brief description of each vegetation type is provided in Table 1.

Grassland vegetation types occupy two-thirds of the site. Within the grassland units occur two sensitive plant communities: vernal pools and purple needlegrass grassland. Vernal pool complexes, including associated ryegrass swales and upland mounds, occur in an area totalling approximately 60 acres in the southeast corner of the reserve. Purple needlegrass is a common component of all grasslands, except the abandoned agricultural lands, but generally occurs in low numbers. Only approximately 100 acres of the site contain a grassland plant community in which purple needlegrass is an important component.

All grassland vegetation types occurring on the site contain a high proportion (>10%) of medusa head. The grasslands are dominated by coarse annual grasses such as medusa head and ripgut brome. Over the past several years, the dead litter of these annual grasses has accumulated into a dense thatch. This biomass may be responsible for the lack of purple needlegrass regeneration and the low diversity of native species. Continued accumulation of this dead litter could provide the fuel for a very hot wildfire which might jeopardize the existing purple needlegrass plants.

Marshes and associated wetland plant communities occupy approximately one-third of the parcel and occur primarily in the historic Lindsey Slough bed. These marshes are a remnant of those which once occupied much of the Sacramento-San Joaquin delta. As such, these areas are important waterfowl and wildlife habitat. The marshes support an apparently healthy ecosystem and no enhancement strategies are recommended. However, if grazing is employed as a grassland management tool, the marshes must be protected from the impacts of grazing animals.

The riparian vegetation on the site is limited to a narrow corridor along the dredged and leveed realignment of Calhoun Cut. Willow scrub, tidal flats and tule marshes occur here. The margins of Barker Slough are occupied by tule marsh and tidal flats. The site lacks the broad floodplains necessary for establishment of riparian forests. The current riparian corridor vegetation appears secure. However, if grazing occurs on the site, this area should be protected through the use of temporary electric fencing.

RARE PLANTS OCCURRENCES

Two vernal pool rare plants, dwarf downingia (*Downingia pusilla*) and legenere (*Legenere limosa*), occur in vernal marsh/vernal pool habitat just south of the Calhoun Cut levee. Additionally, potential habitat for dwarf downingia occurs in the southeast corner of the parcel. These species would probably benefit from grassland management strategies focused on biomass reduction. Italian ryegrass can reduce native species composition and cover through interspecific competition as well as biomass accumulation.

Four species of rare plants which occupy the tidal zone habitat occur along both Calhoun Cut and Barker Slough: Suisun Marsh aster (*Aster lentus*), delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), Mason's lilaeopsis (*Lilaeopsis masonii*) and delta mudwort (*Limosella subulata*). Many new populations of each species were found and mapped during the course of this project. Individually or in combination, these four species occur almost continuously along both banks of both sloughs. Currently, fishing and hunting access pose the greatest threat to these rare plant occurrences. Petroleum product spills could have significant impact to the tidal flat biota along both sloughs. Non-biodegradeable litter such as plastics would tend to amass along the tidal drift line.

RECOMMENDATIONS

The primary land management issue on the Calhoun Cut Ecological Reserve is the accumulation of biomass in the grassland plant communities. A secondary, related issue is the prevalence of medusa head (*Taeniatherum caput-medusae*) and other noxious weeds. Biomass accumulation, particularly dense medusa head thatch, may be preventing the successful germination or establishment of purple needlegrass (*Nassella pulchra*) and other native species. Thatch can also degrade composition and cover of native species in vernal pool complexes.

An aggressive program to remove the current accumulation of biomass is highly recommended. The program should be designed and implemented only after careful review of all available reports and data from grassland management studies conducted on the adjacent Jepson Prairie Preserve.

Once the current level of biomass is reduced, control of vegetative litter on an annual basis might be accomplished through a combination of burning and managed sheep grazing. However, if grazing used as a management tool, the marshes, riparian zone and tidal zone rare plant habitat must be protected from the impacts of grazing animals. Temporary electric fencing can be used to defend these areas. Vernal pools and native grasses may also be negatively impacted by grazing if sheep are held in a pasture for too long, if supplemental feeding is used, or if ranching vehicles drive across the pastures. Supplemental feeding results in introduced weeds, compacted ground and concentrations of sheep manure in the feeding area. Sheep grazing can be a valuable tool for broadleaf weed and thatch control, but careful management and close coordination with the cooperating rancher is essential.

Hunting and fishing access may pose a threat to the rare plants which occur within the tidal zone along the sloughs. Individual plants may be destroyed or damaged by pulling boats to shore over the tidal mud flats. Large groups of plants could be detrimentally impacted by an accumulation of non-biodegradeable litter or by an accidental spill of gasoline or motor oil. At this time, with limited use by hunters, the potential threats are minimal. However, an increase in public use will increase the impacts to the rare plants.

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Photo 1: Marsh vegetation types present within the historic Lindsey Slough bed: Open Water (map unit *OW*) is permanent aquatic habitat within the Tule Marsh (map unit TM) dominated by dense *Scirpus acutus*.

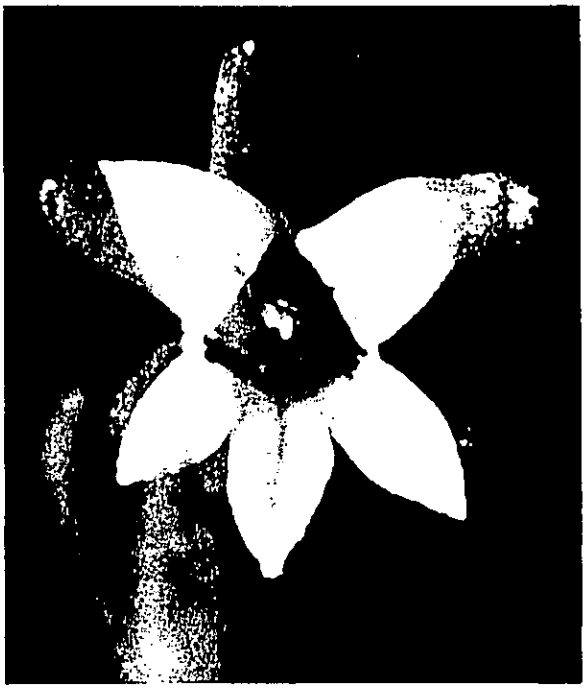
Photo 2: Cattail-Bulrush Marsh (map unit CM), a seasonal marsh in which *Typha* and *Scirpus* are important, but not dominant components. This marsh provides important waterfowl habitat.

Photo 3: Vernal (Alkali) Marsh (map unit VM) in the foreground rings most of the Tule Marsh (map unit TM) visible in middleground. *Distichlis spicata* is a dominant species in this highly alkaline area.

Photo 4: Another view of Vernal (Alkali) Marsh (map unit VM) in foreground with a Tule Marsh (map unit TM) in the left middleground and Annual Grassland (map unit AG) in the right background.

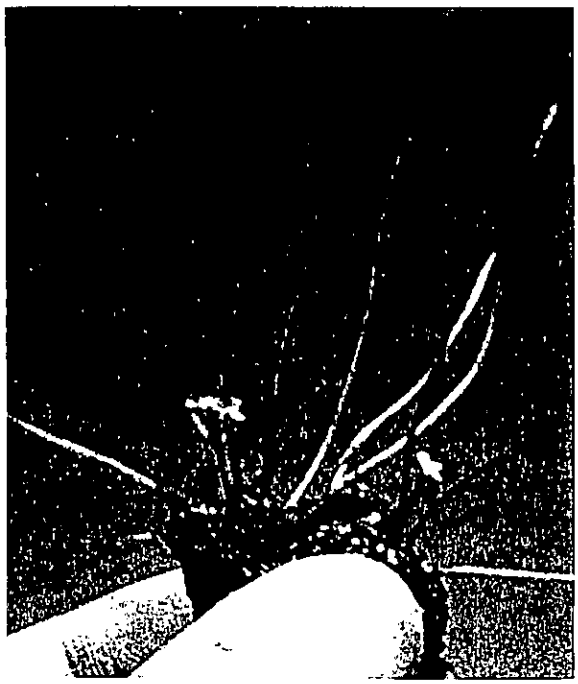
Photo 5: Narrow strip of Willow Scrub (map unit WS) along a leveed portion of Calhoun Cut. Annual Grassland (map unit AG) and Tule Marsh (map unit TM) are both visible in background. Arrow indicates population of *Lilaeopsis masonii* and *Limosella subulata*.

Photo 6: Typical habitat of *Lilaeopsis masonii* and *Limosella subulata*. Tidal flat (map unit TF) in foreground is primary habitat. The edge of the erosion cut, middle left, often supports these species as well.



Downingia pusilla (D. humilis)

Legenere limosa



Lilaeopsis masonii (left)
Limosella subulata (right)

Lathyrus jepsonii
var. *jepsonii*

Photo 7-10: Rare plants of the Calhoun Cut Ecological Reserve. Note that the *Downingia pusilla* is as tiny as the *Legenere limosa* with the flower only 2 mm across.

Appendix IV: Plant species observed on Calhoun Cut Ecological Reserve during the period of May 4 through July 12, 1994. Recent synonymy in parenthesis.

Scientific name	Common name
Aizoaceae	
Sesuvium verrucosum	sea-purslane
Alismataceae	
Alisma plantago-aquatica ssp. *brevipes*	water plantain
Damasonium californicus (*Machaerocarpus c.*)	fringed water-plantain
Amaranthaceae	
Amaranthus blitoides (*A. graecizans*)	prostrate amaranthus
Apiaceae	
Cicuta maculata var. *bolanderi*	Bolander's water-hemlock
Eryngium aristulatum var. *aristulatum*	aristulate coyote-thistle
Eryngium articulatum	jointed coyote-thistle
Eryngium vaseyi (*E. v.* var. *vallicola*)	Vasey's coyote-thistle
Foeniculum vulgare	sweet fennel
Hydrocotyle verticillata (*H. v.* var. *triradiata*)	whorled marsh-pennywort
Lilaeopsis masonii	Mason's lilaeopsis
Lomatium caruifolium var. *denticulatum*	caraway-leaved lomatium
Oenanthe sarmentosa	water-parsley
Torilis arvensis	hedge parsley
Apocynaceae	
Apocynum cannabinum	Indian hemp
Asclepidaceae	
Asclepias fascicularis	narrow-leaved milkweed
Asteraceae	
Achillea millifolium	yarrow
Achyrachaena mollis	blow-wives
Ambrosia artemisifolia	sage ragweed
Anthemis cotula	dog fennel
Aster chilensis	common aster
Aster lentus (*A. chilensis* var. *l.*)	Suisun Marsh aster
Aster subulatus var. *ligulatus* (*A. exilis*)	slender aster
Baccharis salicifolia (*B. viminea*)	mulefat
Blennosperma nanum var. *nanum*	yellow carpet
Centaurea calcitrapa	purple starthistle
Centaurea solstitialis	yellow star-thistle
Chamomilla suaveolens (*Matricaria matricarioides*)	pineapple weed
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Cotula coronopifolia	brass buttons
Euthamia occidentalis (*Solidago o.*)	western goldenrod
Filago gallica	filago
Gnaphalium luteo-album	weedy cudweed
Gnaphalium palustre	cudweed
Helenium puberulum	rosilla
Hemizonia congesta ssp. *luzulifolia* (*H. luzulifolia*)	white tarweed
Hemizonia fitchii	Fitch's spikeweed
Holocarpa virgata ssp. *virgata*	twiggy tarweed
Hypochaeris glabra	smooth cat's-ear

Appendix IV: Plant list (continued).

Scientific name	Common name
Asteraceae (continued)	
Lactuca saligna	willow-leaf lettuce
Lactuca serriola	prickly lettuce
Lasthenia californica	California goldfields
Lasthenia chrysantha	goldfields
Lasthenia fremontii	Fremont's goldfields
Lasthenia glaberrima	smooth goldfields
Lasthenia platycarpha	goldfields
Layia chrysanthemoides	tidy-tips
Microseris acuminata	common microseris
Microseris campestris	San Joaquin microseris
Microseris douglasii ssp. *douglasii*	Douglas's microseris
Picris echioides	bristly oxtongue
Pluchea odorata	salt marsh fleabane
Psilocarphus brevissimus var. *brevissimus*	dwarf woolly-marbles
Psilocarphus oregonus	Oregon woolly-marbles
Senecio vulgaris	common goundsel
Silybum marianum	milk thistle
Sonchus asper ssp. *asper*	prickly sowthistle
Sonchus oleraceus	common sowthistle
Tragopogon porrifolius	purple salsify
Xanthium strumarium (*X. s.* var. *canadense*)	rough cockle-bur
Betulaceae	
Alnus rhombifolia	white alder
Boraginaceae	
Amsinkia menziesii var. *intermedia* (*A. intermedia*)	fiddleneck
Heliotropium curassavicum	common heliotrope
Plagiobothrys greenei (*Allocarya g.*)	Greene's popcorn flower
Plagiobothrys humistratus (*Allocarya h.*)	dwarf popcornflower
Plagiobothrys leptocladus (*Allocarya l.*)	smooth-stemmed popcorn flower
Plagiobothrys stipitatus var. *micrantha* (*Allocarya s.* var. *m.*)	small-flowered popcorn flower
Plagiobothrys undulatus (*Allocarya u.*)	coast popcorn-flower
Brassicaceae	
Capsella bursa-pastoris	shepherd's purse
Cardamine oligosperma	western bittercress
Lepidium latifolium	perennial peppergrass
Lepidium nitidum var. *nitidum*	shining peppergrass
Raphanus raphanistrum	yellow wild radish
Rorippa palustris var. *occidentalis*	bog yellow-cress
Callitrichaceae	
Callitriche heterophylla var. *bolanderi*	vari-leaved water-starwort
Callitriche marginata	California water-starwort
Campanulaceae	
Downingia concolor var. *concolor*	maroon-spotted downingia
Downingia pulchella	flat-faced downingia
Downingia pusilla (*D. humilis*)	dwarf downingia
Legenere limosa	legenere

Appendix IV: Plant list (continued).

Scientific name	Common name
Caprifoliaceae	
Lonicera japonica	japanese honeysuckle
Sambucus mexicanus	blue elderberry
Caryophyllaceae	
Cerastium glomeratum	mouse-eared chickweed
Silene gallica	windmill pink
Spergula arvensis ssp. *arvensis*	spurrey
Spergularia macrotheca var. *leucantha*	large-flowered sandspurrey
Spergularia rubra	ruby sandspurrey
Chenopodiaceae	
Atriplex fruticosa	ball saltbush
Atriplex patula var. *patula*	spear oracle
Atriplex semibaccata	Australian saltbush
Atriplex triangularis (*A. patula* var. *hastata*)	spearscale
Chenopodium album	lambs quarter
Chenopodium chenopodioides	red goosefoot
Salicornia subterminalis	alkali pickleweed
Suaeda calceoliformis (*S. occidentalis*)	sea-blite
Suaeda moquinii	bush seepweed
Convolvulaceae	
Calystegia sepium	hedge bindweed
Convolvulus arvensis	bindweed
Cressa truxillensis (*C. t.* var. *vallicola*)	alkali weed
Cornaceae	
Cornus sericea ssp. *sericea* (*C. occidentalis*)	western dogwood
Crassulaceae	
Crassula aquatica	water pigmyweed
Crassula tillaea (*C. muscosa*)	moss pigmy-weed
Cupressaceae	
Cupressus arizonica ssp. *arizonica* (planted)	Arizona cypress
Cuscutaceae	
Cuscuta howelliana	Bogg's Lake dodder
Cyperaceae	
Carex barbarae	Santa Barbara sedge
Carex praegracilis	clustered field sedge
Cyperus eragrostis	tall flat-sedge
Eleocharis acicularis var. *acicularis*	little spike-rush
Eleocharis macrostachya	pale spike-rush
Scirpus acutus var. *occidentalis*	hard-stem bulrush
Scirpus americanus (*S. olneyi*)	American tule
Scirpus cernuus	low club-rush
Scirpus maritimus	maritime tule
Equisetaceae	
Equisetum hyemale ssp. *affine*	rough horsetail

Appendix IV: Plant list (continued).

Scientific name	Common name
Euphorbiaceae	
Eremocarpus setigerus	turkey-mullein
Fabaceae	
Astragalus gambelianus	dwarf locoweed
Hoita macrostachya (*Psoralea m.*)	leather-root
Lathyrus jepsonii var. *jepsonii*	tule pea
Lotus corniculatus	bird's-foot trefoil
Lotus denticulatus	pink trefoil
Lotus purshianus var. *purshianus*	Spanish lotus
Lupinus bicolor (*L. b.* var. *pipersmithii*)	two-colored lupine
Medicago polymorpha	bur clover
Medicago sativa	alfalfa
Melilotus alba	white sweetclover
Melilotus indica	sourclover
Robinia pseudoacacia (planted)	black locust
Trifolium barbigerum var. *barbigerum*	bearded clover
Trifolium campestre	hop clover
Trifolium depauperatum var. *depauperatum*	dwarf sack clover
Trifolium dubium	shamrock
Trifolium gracilentum	pin-point clover
Trifolium hirtum	rose clover
Trifolium microcephalum	small-head clover
Trifolium repens	white clover
Trifolium willdenovii (*T. tridentatum*)	tomcat clover
Vicia sativa ssp. *nigra*	spring vetch
Vicia villosa ssp. *villosa*	winter vetch
Quercus lobata	valley oak
Frankeniaceae	
Frankenia salina (*F. grandiflora* var. *campestris*)	alkali frankenia
Gentianaceae	
Centaurium muehlenbergii (*C. floribundum*)	June centaury
Geraniaceae	
Erodium botrys	broad-leaf filaree
Erodium brachycarpum (*E. obtusiplicatum*)	foothill filaree
Erodium cicutarium	lace-leaved filaree
Geranium dissectum	cut-leaved geranium
Haloragaceae	
Myriophyllum cf. *spicatum*	millfoil
Iridaceae	
Sisyrinchium bellum	blue-eyed grass
Isoetaceae	
Isoetes howellii	Howell's quillwort
Isoetes orcuttii	Orcutt's quillwort
Juglandaceae	
Juglans californica var. *hindsii* (*J. hindsii*)	northern California walnut

Appendix IV: Plant list (continued).

Scientific name	Common name
Juncaceae	
Juncus acutus	spiny rush
Juncus balticus	Baltic rush
Juncus bufonius var. *occidentalis*	toad rush
Juncus effusus var. *pacificus*	soft rush
Juncus mexicanus	Mexican rush
Juncus uncialis	inch-high dwarf rush
Juncus xiphioides	iris-leaved rush
Juncaginaceae	
Lilaea scilloides	flowering quillwort
Triglochin maritima	seaside arrow-grass
Lamiaceae	
Lycopus americanus	American water-horehound
Marrubium vulgare	horehound
Mentha arvense	tule-mint
Pogogyne zizyphoroides	Sacramento pogogyne
Prunella vulgaris var. *lanceolata*	self-heal
Stachys ajugoides var. *rigida* (*S. rigida*)	rigid hedge-nettle
Stachys albens	white-stem hedge-nettle
Lemnaceae	
Lemna sp.	duckweed
Liliaceae	
Asparagus officinalis	asparagus
Brodiaea coronaria ssp. *coronaria*	crown brodiaea
Brodiaea elegans ssp. *elegans*	elegant brodiaea
Calochortus luteus	yellow mariposa lily
Chlorogalum angustifolium	narrow-leaved soaproot
Muilla maritima	common muilla
Triteleia hyacinthina	white hyacinth
Triteleia peduncularis	long-rayed brodiaea
Limnanthaceae	
Limnanthes douglasii ssp. *rosea*	rose-veined meadowfoam
Lythraceae	
Lythrum californica	California loosestrife
Lythrum hyssopifolia	hyssop loosestrife
Malvaceae	
Malva parviflora	cheeseweed
Malvella leprosa (*Sida l.* var. *hederacea*)	alkali mallow
Sidalcea hirsuta	hairy checkerbloom
Marsileaceae	
Marsilea vestita ssp. *vestita*	water shamrock
Pillularia americana	pill-wort
Moraceae	
Ficus carica	domestic fig

Appendix IV: Plant list (continued).

Scientific name	Common name
Myrtaceae	
Eucalyptus globulus (planted)	blue gum
Oleaceae	
Fraxinus latifolia	Oregon ash
Olea europaea (planted)	olive
Onagraceae	
Epilobium brachycarpum (*E. paniculatum*)	panicled willow-herb
Epilobium ciliolatum ssp. *watsonii*	hairy willowherb
Epilobium cleistogamum (*Boisduvalia c.*)	spike-primrose
Epilobium torreyi (*Boisduvalia stricta*)	spike-primrose
Ludwigia peploides ssp. *peploides*	yellow waterweed
Plantaginaceae	
Plantago coronopus	fern-leaf plantain
Plantago elongata (*P. bigelovii*)	Bigelov's plantain
Plantago erecta	dwarf plantain
Plantago lanceolata	English plantain
Plantago subnuda	plantain
Poaceae	
Aegilops triuncialis	barb goatgrass
Agrostis avenacea	hairy-flower bentgrass
Agrostis exarata	spike bentgrass
Aira caryophyllea	silver hairgrass
Alopecurus saccatus	Pacific meadow-foxtail
Arundo donax	giant reed
Avena barbata	slender wild oat
Avena fatua	wild oat
Briza minor	little quaking grass
Bromus diandrus	ripgut brome
Bromus hordeaceus (*B. mollis*)	shoft chess brome
Crypsis schoenoides	crypsis
Crypsis vaginiflora (*C. niliaca*)	swampgrass
Cynodon dactylon	Bermuda grass
Deschampsia danthoioides	annual hairgrass
Distichlis spicata (*D. s.* var. *nana*)	salt grass
Gastridium ventricosum	nitgrass
Hordeum brachyantherum ssp. *brachyantherum*	meadow barley
Hordeum depressum	low barley
Hordeum jubatum	hair barley
Hordeum marinum ssp. *gussoneanum* (*H. geniculatum*)	bent-knees barley
Hordeum murinum ssp. *leporinum* (*H. leporinum*)	foxtail barley
Leymus triticoides (*Elymus t.*)	creeping wild-rye
Lolium multiflorum	rye-grass
Lolium perenne	rye-grass
Nassella pulchra (*Stipa p.*)	purple needlegrass
Parapholis incurva	sickle grass
Paspalum dilatatum	dallis grass
Paspalum distichum	knot-grass
Phalaris lemmonii	Lemmon's canary grass
Phalaris paradoxa	paradox canary grass
Phragmites australis	common reed

Appendix IV: Plant list (continued).

Scientific name	Common name
Poaceae (continued)	
Pleuropogon californicus	California semaphoregrass
Poa annua	annual bluegrass
Poa secunda ssp. *secunda* (*P. scabrella*)	pine bluegrass
Polypogon monspeliensis	rabbit's foot
Puccinellia nuttalliana	Nuttall's alkali grass
Setaria sphacelata	African bristle-grass
Taeniatherum caput-madusae (*Elymus c.-m.*)	medusa head
Vulpia bromoides	six-weeks fescue
Vulpia myuros	rattail fescue
Polemoniaceae	
Linanthus liniflorus (*L. l.* ssp. *pharnaceoides*)	flax-flowered linanthus
Navarretia intertexta ssp. *intertexta*	blue navarretia
Navarretia leucocephala ssp. *leucocephala*	white navarretia
Polygonaceae	
Polygonum amphibium var. *stipulaceum*	water smartweed
Polygonum amphibium var. *emersum* (*(P. cocciceum)*)	tall water smartweed
Polygonum arenastrum (*P. aviculare*)	common knotweed
Polygonum hydropiperoides	swamp smartweed
Polygonum persicaria	Lady's thumb
Polygonum punctatum	dotted smartweed
Rumex conglomeratus	clustered dock
Rumex crispus	curly dock
Rumex pulcher	fiddle dock
Rumex salicifolius var. *salicifolius*	willow-leaved dock
Portulacaceae	
Claytonia perfoliata ssp. *mexicana*	miner's lettuce
Potamogetonaceae	
Potamogeton pectinatus	sago pondweed
Primulaceae	
Anagalis arvense	scarlet pimpernel
Samolus parviflorus	water pimpernel
Ranunculaceae	
Ranunculus aquatilis var. *capillaceus*	water buttercup
Ranunculus aquatilis var. *hispidulus*	water buttercup
Rosaceae	
Prunus amygdalus (planted)	almond
Pyrus communis	common pear
Rosa californica	California rose
Rubus discolor (*R. procerus*)	Himalaya-berry
Rubus ursinus	California blackberry
Rubiaceae	
Cephalanthus occidentalis var. *californicus*	buttonbush
Salicaceae	
Populus fremontii	Fremont's cottonwood

Appendix IV: Plant list (continued).

Scientific name	Common name
Salicaceae (continued)	
Salix exigua (*S. hindsiana*)	sandbar willow
Salix gooddingii	Goodding's willow
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Salviniaceae	
Azolla filiculoides	common mosquito fern
Saururaceae	
Anemopsis californica	yerba mansa
Scrophulariaceae	
Limosella subulata	marsh mudwort
Mimulus guttatus	common monkeyflower
Triphysaria eriantha ssp. *eriantha* (*Orthocarpus* e.)	johnny tuck
Veronica peregrina ssp. *xalapensis*	persiane speedwell
Simaroubaceae	
Ailanthus altissima (planted)	tree-of-heaven
Solanaceae	
Solanum americanum (*S. nodiflorum*)	nodding nightshade
Tamaricaceae	
Tamarix sp. (planted)	tamarisk
Typhaceae	
Typha angustifolia	narrowleaf cattail
Typha latifolia	broadleaf cattail
Urticaceae	
Urtica dioica ssp. *holosericea*	hoary nettle
Verbenaceae	
Phyla nodiflora var. *nodiflora* (*Lippia n.* var. *reptans*)	mat-grass
Verbena hastata	blue vervain
Vitaceae	
Vitis californica	California wild grape
Vitis vinifera (planted)	cultivated grape
Zannichelliaceae	
Zannichellia palustris	horned pondweed

Appendix IVb: Butterfly species observed on Calhoun Cut Ecological Reserve during the period of May 4 through July 12, 1994.

Species Name	Common Name	Habitat
Erynnis tristis tristis	Mournful Dusky Wing	Only in oak woodland
Pyrgus scriptura	Small Checkered Skipper	Near host plant *Malvella leprosa*
Pyrgus communis	Checkered Skipper	Marsh edges
Pholisora catullus	Common Sooty Wing	Marsh edges
Polites sabuleti sabuleti	Sandhill Skipper	Marsh edges
Atalopedes campestris campestris	Sachem	Marsh edges
Ochlodes sylvanoides sylvanoides	Woodland Skipper	Marsh edges
Ochlodes yuma	Yuma Skipper	Near host plant *Phragmites australis*
Battus philenor hirsuta	Pipe-vine Swallowtail	Riparian corridor
Papilio zelicaon	Anise Swallowtail	General
Papilio rutulus	Western Tiger Swallowtail	Riparian corridor
Pieris rapae	Cabbage Butterfly	General
Colias eurytheme	Alfalfa Butterfly	Riparian corridor
Lycaena xanthoides xanthoides	Great Copper	Marsh edges, near *Rumex* spp.
Lycaena helloides	Purplish Copper	Marsh edges
Satyrium sylvinum sylvinum	Silvan Hairstreak	Near host *Salix exigua (S. hindsiana)*
Strymon melinus pudicus	Gray Hairstreak	Riparian corridor
Brephidium exilis	Pygmy Blue	Near host plant *Atriplex* spp.
Everes comyntas comyntas	Eastern Tailed Blue	Near host plant *Lathyrus jepsonii*
Icaricia acmon acmon	Acmon Blue	Marsh edges
Phyciodes campestris campestris	Field Crescent	Near host plant *Aster* spp.
Phyciodes mylitta mylitta	Mylitta Crescent	Riparian corridor
Nymphalis antiopa	Mourning Cloak	Riparian corridor
Vanessa virginiensis	American Painted Lady	Near nectar source (ie. *Cirsium*)
Vanessa cardui	Painted lady	Near nectar source (ie. *Cirsium*)
Vanessa anabella	West Coast Lady	Near nectar source (ie. *Cirsium*)
Vanessa atalanta	Red Admiral	Marsh edges, near *Urtica dioica*
Precis coenia	Buckeye	Road edges
Limenitis lorquini	Lorquin's Admiral	Riparian corridor
Coenonympha tullia californica	California Ringlet	Grassland
Danaus plexippus	Monarch	General, near *Asclepias fascicularis*

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Statement of Qualifications

- Extensive field experience in plant taxonomy and floristic survey methods. Familiar with many California and Nevada plant communities including their rare, threatened and endangered plants. Experience in avoidance/mitigation planning plus habitat restoration/recreation.

Related Experience - biological consulting; contracts since 1989 include

- **Rare, threatened and endangered plant surveys** for public and private concerns in a variety of habitats in Calaveras, Colusa, Contra Costa, El Dorado, Glenn, Lake, Lassen, Placer, Plumas, Sacramento, Shasta, Sierra, Solano, Tehama, Tuolumne and Yolo counties in California. Field mapping, mitigation and species conservation guidelines preparation.
- **Wetland delineations** for a large public utilities project in Alameda, Colusa, Contra Costa, Glenn, Merced, San Joaquin, Shasta, Solano, Stanislaus, Tehama and Yolo counties. Coordinate field personnel. Project included extensive mapping and plant community characterization for mitigation restoration efforts. Additional wetland delineation work for public and private concerns in Calaveras, El Dorado, Sacramento and Tuolumne counties.
- **Quantitative field sampling of vernal pool vegetation** for a public utilities project in Colusa, Glenn, Shasta, Solano and Tehama counties. Includes identification and mapping of rare plants, data analyses, mitigation/restoration plan recommendations, liaison with restoration subcontractors, construction monitoring, mitigation monitoring, mitigation parcel acquisition recommendations, plus supervision and training of all botanical support personnel. Numerous other vernal pool surveys and assessments in Butte, El Dorado, Lake, Merced, Placer, Sacramento, Solano and Sutter counties.
- **Quantitative field sampling of riparian vegetation** along Bishop and Pine creeks in Inyo County and Mill Creek in Mono County. Refine field sampling protocol. Supervise botanists and technical field support personnel. Mapping, data analyses, interpretation and reporting on a public utilities FERC mandated monitoring project.
- **Focused rare, threatened and endangered plant surveys** for *Astragalus tener* var. *tener* in Solano and Yolo counties; *Ivesia webberi* in Lassen, Plumas and Sierra counties in California and Douglas and Washoe counties in Nevada; *Gratiola heterosepala* in Glenn and Tehama counties.
- **Wetland management plans** for several wetland mitigation proposals. Review proposed wetland management or mitigation plans; provide alternative recommendations and propose monitoring guidelines.

Publications

- Witham, Carol W. (Ed.). 1989. *Jepson Prairie Preserve - field guide*. The Nature Conservancy, San Francisco, California. 67 pp.
- Kareofelas, Greg A. and Carol W. Witham. 1991. Twenty seven volume index by author, subject and geopolitical region. *J. Res. Lepidoptera*. 1992 Special Publication. 87 pp.
- Witham, Carol W. 1993. The role of vernal pools in the 1992 mass dispersal of *Vanessa cardui* (Nymphalidae) with new larval hostplant records. *J. Res. Lepidoptera* 30(3-4):302-304.
- Witham, Carol and Greg Kareofelas. 1993. *Take a walk in the forest with us: a brief tour of the rain forest ecology of Hacienda Tropicale*. Centro Ecologico Hacienda Tropicale, Caracas, Venezuela. 34 pp.

Honors & Awards

- Outstanding Volunteer Service Award, The Nature Conservancy. 1989.
- Rare Plant Conservation Award, California Native Plant Society. 1992.

Other Experience - personal research and volunteer work

- Extensive distributional analyses and habitat studies of the rare, threatened and endangered plants of California; rare plant reporting and mapping for a wide variety of taxa throughout northern California and northern Nevada (1986-present).
- Discoverer of a new species of annual *Juncus* in Shasta County, California (1992).
- Rare plant monitoring for *Fritillaria liliaceae*, *Gratiola heterosepala*, *Tuctoria mucronata* and *Neostapfia colusana* in Solano County; *Cordylanthus palmatus* in Yolo County; *Fritillaria pluriflora* in Colusa County (1987-present).
- Habitat restoration: riparian woodland in Solano County (1987-1990); *Stipa pulchra* grassland in Solano County (1992-present); *Darlingtonia* fen in Plumas County (1989); vernal pools in Glenn, Solano, Shasta and Tehama counties (1992-present). Habitat creation: vernal pools and *Stipa cernua* grassland in Yolo County (1987-present).
- Chairperson, rare plant committee, Sacramento Valley Chapter, California Native Plant Society (1989-present). Coordinate all herbaria, library and CNDDB researcher, plus illustrators and other volunteers for upcoming rare plant information booklets (1992-present).
- Chairperson, plant watch committee, Sacramento Valley Chapter, California Native Plant Society (1989-present).
- Member, University of California Davis-The Nature Conservancy Joint Management Committee for Jepson Prairie Preserve (1988-1991).
- Designer and trail guide author, self-guided interpretative trail at the TNC Jepson Prairie Preserve, Solano County (1991).
- Member, Committee to review Sacramento County Tree Preservation and Protection Ordinance (1991).
- Occasional field trip leader for California Native Plant Society, Northern Nevada Native Plant Society, The Nature Conservancy, and the Wildlands Program of the California Department of Fish and Game, and a variety of other conservation groups (1987-present).
- Volunteer docent, TNC Jepson Prairie Preserve, Solano County (1986-1990). Volunteer docent trainer, TNC Jepson Prairie Preserve, Solano County (1991-present).
- Participant, Annual Inter-Institutional Haybaling Expedition (1989-present); University of California Berkeley Museum of Paleontology-Far West Geoscience Foundation Joint Paleobotanical Field Expeditions (1990-present); Annual Xerces Society Butterfly Count on Mount Diablo (1990) and on Sonora Pass (1991).
- Guest field investigator, biological inventory and ecotourism assessment *Zona de Reserva Geobotanica, Crater del Volcan Pululahua*, Pichincha Province, Ecuador (Jan-Feb 1992); *Centro Ecologico Hacienda Tropicale*, Yaracuy State, Venezuela (Jan-Feb 1993); *Reserva de Produccion Faunistica Cuyabeno*, Sucumbios Province, Ecuador (Nov-Dec 1993).

References available upon request.