

Description and Analysis of the Botanical Resources,

Including Vascular Plant Species of Conservation Concern,

**at the Chevron Tank Farm Facility
San Luis Obispo, California**

Final Report

Prepared for:

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Executive Summary

One hundred fifty-two (152) vascular plant species have been identified within the property boundaries of the San Luis Obispo Tank Farm. This listing combines previous field surveys as well as the 2008 surveys by the Padre/WSP project team. Forty-nine percent (49%; 74 taxa) of the vascular plant species are native taxa, while 51% (78 taxa) are non-native (primarily naturalized) species commonly represented in the California flora. The percentage of non-native taxa on the San Luis Obispo Tank Farm is more than twice that calculated for the State as a whole, reflecting a relatively high level of site disturbance associated with past oil operations, maintenance, and abandonment, and past and continued cattle grazing.

Seven species are of concern to the conservation community. Six have been identified by the California Native Plant Society as species in decline, and are therefore acknowledged under the California Environmental Quality Act as significant biological resources at the San Luis Obispo Tank Farm.

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I. INTRODUCTION & BACKGROUND

In July of 2007, WSP Environment & Energy (WSP) was asked by Chevron Environmental Management Company (hereafter “CEMC”) to assist Padre Associates, Inc. (hereafter “Padre”) with inventory and description of the botanical resources, including vascular plant species of conservation concern, at on the San Luis Obispo Tank Farm (hereafter “SLO Tank Farm”) project site. Union Oil Company of California owns the 340-acre Tank Farm property, which is located immediately south of the City of San Luis Obispo, in San Luis Obispo County, California (Figures 1 and 2). The SLO Tank Farm abuts the East Fork of San Luis Obispo Creek, which is an infrequently intermittent to perennial tributary to the “traditionally navigable waters” of the Pacific Ocean. SLO Tank Farm is not within the designated “Coastal Zone” in San Luis Obispo County as designated by the California Public Resources Code Division 20, §§30000 – 30012.

In this report, the WSP/Padre technical team provides results of their field surveys of the geographic distribution of rare plant species of conservation concern on the SLO Tank Farm.

This effort was developed by the WSP/Padre team using (a) existing environmental documents (EDAW [1999], Jenesis [2003], and Rincon Associates [2003]) and (b) a combination of 2007-2008 field-based observations of the vegetation combined with taxon-specific field surveys at the SLO Tank Farm. The information offered in this report is arranged with the intention to: (1) introduce and briefly describe the existing vegetation on the SLO Tank Farm, (2) offer a revised classification of the plant communities on project site, (3) provide technical results, (4) discuss the pertinent regulatory contexts and issues at the federal, state, and local levels of jurisdiction, and (5) offer a mitigation and management strategy that includes plant propagule collection strategy, collection protocols, and propagation techniques.

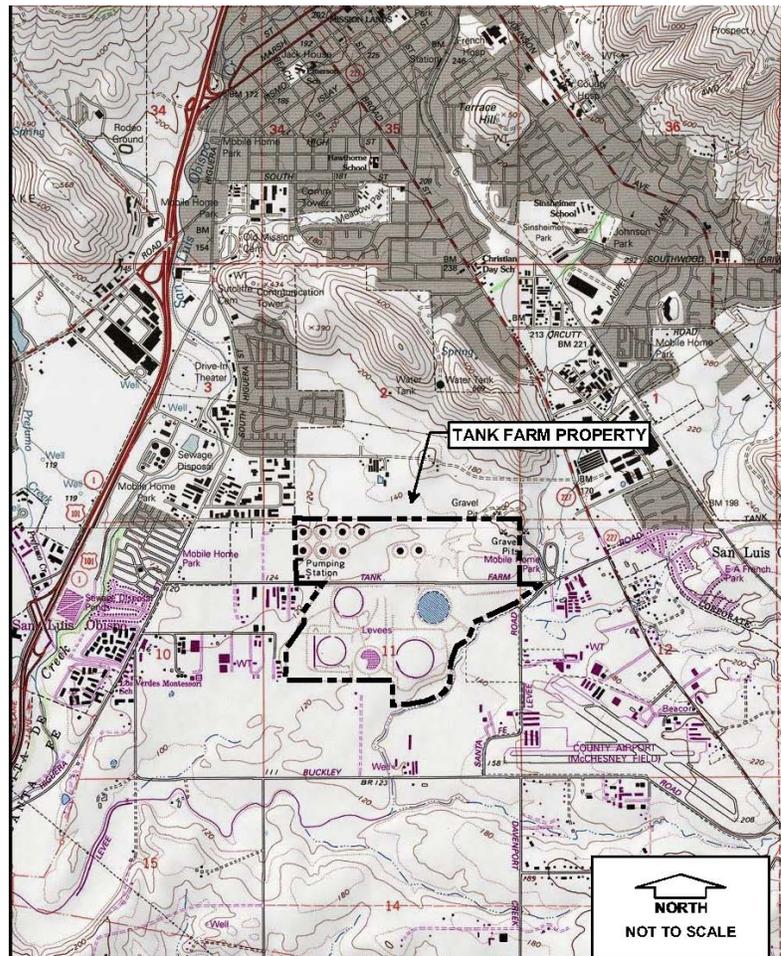


Figure 1. Chevron SLO Tank Farm project site (from Padre Associates, Inc. 2007).

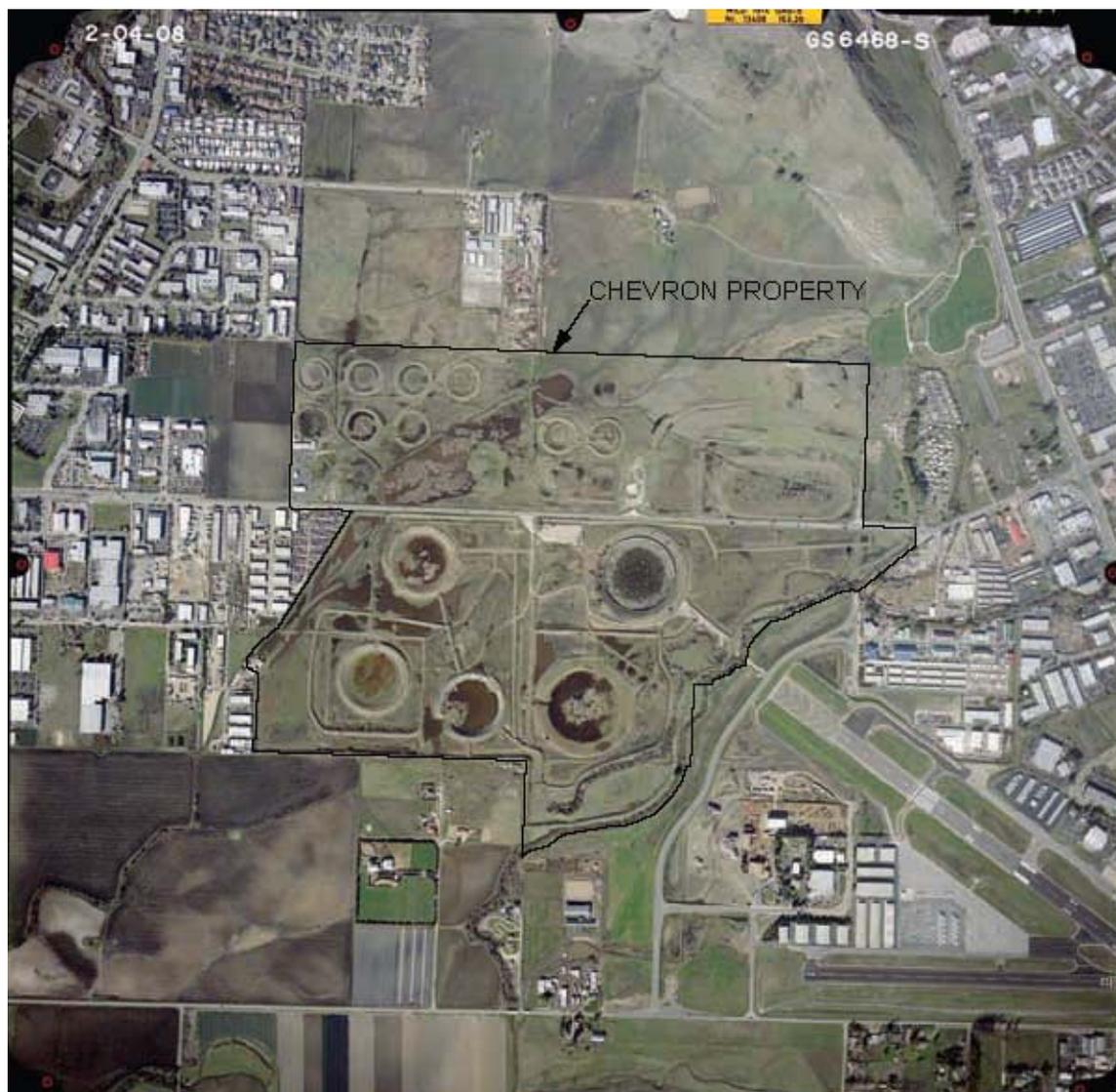


Figure 2. Aerial Image of Chevron SLO Tank Farm project site (Flight Date February 4, 2008).

II. OVERVIEW OF SITE CHARACTERISTICS

A. *Current and Historic Land Uses*

The SLO Tank Farm is owned by Union Oil Company of California (Union Oil). Storage facilities and supporting infrastructure were constructed in 1910 to serve as the tidewater accumulation point for the petroleum pipeline from the San Joaquin Valley. The tank farm facility was withdrawn slowly from Union Oil operations during the later decades of the twentieth century, and by the late 1990s, it was formally decommissioned (Avocet Environmental 2007).

With the exception of a small area of office buildings located in the western portion of the property, the SLO Tank Farm site primarily is open space (Figure 2, Photograph 1). For the past several decades, tank farm lands have been leased for both intensive and extensive cattle grazing for the purposes of fire and weed control. Adjacent land uses include the San Luis Obispo County Airport to the south, and light commercial and industrial developments, agricultural and pastoral land with scattered residences, and a trailer park to the east.

At the SLO Tank Farm, topography, soils, and vegetation have been altered considerably through plowing and disking, catastrophic fire, grazing of domestic livestock, construction and removal of oil storage tanks and their surrounding berms, stream channelization, construction of water and oil management and containment systems, and several other anthropogenic alterations. Currently, most of the SLO Tank Farm is dominated by non-native species of forbs and grasses (Photograph 2). However, some scrub/shrub and forested plant communities occur in wet depressions or within riparian corridors associated with East Fork of San Luis Obispo Creek and its tributaries (Photographs 4). Waters of the U.S., including wetlands, in the form of riverine, depressional, and small slope ecosystems are prominent throughout the SLO Tank Farm (Padre & WSP 2008). Many of the waters/wetlands on the property are associated with natural features such as swales, small riverine channel systems, or depressions. However, some of the depressional and slope wetlands are associated with human-made depressions that remain after decommissioning of oil storage facilities or after various mining or domestic livestock management operations.



Photograph 1. SLO Tank Farm project site looking north from the southern portion across Tank Farm Road.

B. *Geomorphology and Landscape Context*

The SLO Tank Farm is located in a geologically complex and seismically active region. The underlying geologic structure has been formed during millions of years of folding and faulting as

the Pacific plate moves north along the North American plate. Geologic structure in this landscape is oriented primarily in a northwesterly direction with the coast range.



Photograph 2. Non-native herbaceous species dominate the grasslands on the project site, including wild oats (*Avena barbata*), mayweed (*Anthemis cotula*), and fennel (*Foeniculum vulgare*) featured in the foreground.

From the perspective of surficial processes and landforms, the SLO Tank Farm is located in a coastal basin that is partially filled with late Pleistocene and early Holocene alluvium. The northern portion of the site is characterized by a slope/riverine wetland complex that serves as the headwaters of a small, unnamed tributary (locally known as “Tank Farm Creek”) of the East Fork of San Luis Obispo Creek. This tributary has been mostly disconnected from East Fork of San Luis Obispo Creek due to historic road construction, water and oil management operations, and other anthropogenic activities.

Underlying geology of the north half of the SLO Tank Farm site includes a colluvial toe slope near the northern property boundary that grades generally south and onto valley alluvium.

Alluvial soils dominate the central and southern portions of the site. The valley alluvial surfaces are approximately 8,000-10,000 years old while the colluvial toe slope on the northern property boundary is a somewhat older surface. The extreme southern portion of the SLO Tank Farm site, generally on the southern property boundary, has been shaped by the East Fork of San Luis Obispo Creek channel system as it has alternatively incised and migrated back and forth across the basin floor (Figure 2).

C. Climate

The San Luis Obispo area has a mild, Mediterranean climate with warm, dry summers and wetter, cooler winters. The average maximum temperature (by month) ranges from 63 °F in January to 79.5 °F in September. Average minimum temperatures range between 41.6 °F in Jan and 53 °F in August (Station No. 047851-4) (Western Region Climate Center [WRCC] 2007). In this coastal area, the majority of precipitation comes as rainfall during the winter months (Nov–April). Average annual precipitation is 23.45 inches (WRCC 2007).

III. VEGETATION

A. Background & Overview

Vegetation on the SLO Tank Farm project site has been described by EDAW (1999), Jenesis (2003), Rincon Associates (2003-2004), and Padre & WSP (2008a, 2008b). The focus of these reports has been the description of the waters of the U.S., including wetlands. However, a less comprehensive description of waters/wetlands features is included in this report.

The flora and vegetation of California's central coastal regions is diverse and structurally complex, reflecting the diverse topography, geology, climate, and soil types of the region. As discussed in many other fora (*e.g.*, Matthews 1997, Smith 1998, Barbour *et al.* 2007), the plant communities in this biogeographic region consequently range from wet forests (*e.g.*, coast redwood [*Sequoia sempervirens*]) to the desert-like moonscapes of the ultramafic regions of interior San Benito County. Rare as well as local endemics are known from all of the major plant communities in this biogeographic region.

Major vegetation types in the Monterey-San Luis Obispo-Santa Barbara central coast region include oak woodlands and forests (Pavlik *et al.* 1991, Allen-Diaz *et al.* 2007), coniferous forests (Barbour 2007, Minnich 2007), annual and perennial bunchgrasslands (Bartolome 2007), chaparral (Keeley & Davis 2007), sage scrub (Rundel 2007), coastal prairie (Ford and Hayes 2007), beach and dune vegetation (Pickart & Barbour 2007); marine, estuarine, riverine, lacustrine, and palustrine wetland systems (Cowardin *et al.* 1979; Ferren, Fiedler & Leidy 1996; Grewell, Callaway, & Ferren 2007; Solomeshch, Barbour & Holland 2007). Not all of these vegetation types are present on the project site today, and those that do exist (*e.g.*, grassland, willow riparian forest) are highly degraded in large part through a century of intensive and extensive land uses.

Grassland areas within the region which are not frequently disturbed are characterized by a native perennial bunch grassland community type which has an occasional tree or shrub (*e.g.*, Mexican elderberry [*Sambucus mexicana*]). Widespread grassland species, both native and non-native, found in the SLO Tank Farm project site (EDAW 1999) include rigpgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), purple needlegrass (*Nassella pulchra*), tarweed (*Deinandra congesta* ssp. *luzulifolia*, *Deinandra fasciculata*, and *Centromadia parryi* ssp. *congdonii*), San Luis Obispo owl's clover (*Castilleja densiflora* ssp. *obispoensis*), and sweet fennel (*Foeniculum vulgare*). Exotics occurring in the most intensively disturbed areas within the uplands include those species listed above as well as yellow star-thistle (*Centaurea solstitialis*), totalote (*Centaurea melitensis*), mayweed (*Anthemis cotula*), wild oats (*Avena barbata*), annual fescue (*Vulpia myuros* var. *hirsuta*), Italian ryegrass (*Lolium multiflorum*), black mustard (*Brassica nigra*), wild radish (*Raphanus sativus*), and sweet fennel.

Shrublands include a wide variety of vegetation types in central coastal California, including a suite of chaparral types (*e.g.*, chamise-dominated [*Adenostoma fasciculatum*], manzanita-dominated [*Arctostaphylos* spp.], coyote brush-dominated [*Baccharis pilularis*]; deerbrush-dominated [*Ceanothus* spp.], and oak-dominated [*Quercus* spp.]); California sagebrush-dominated (*Artemisia californica*); black-sage-dominated (*Salvia mellifera*), among others). Only a small proportion of the SLO Tank Farm project site supports any shrublands at present.

Additional information regarding shrub-dominated vegetation in California can be found in Barbour, Keeler-Wolf, & Schoenherr (2007).

Plant communities along the streams of the central coast of California support a dynamic complement of native trees and other woody species, many of which can and do occur outside of the riparian corridor. Perhaps the most conspicuous feature of the mature, native riparian vegetation within the southern portion of California's central coast is the dominance of large coast live oaks (*Quercus agrifolia*), western sycamore (*Platanus racemosa*), and Fremont cottonwood (*Populus fremontii*). Stands of live oak range in density from woodland (wherein individual tree canopies do not interdigitate) to forest (*i.e.*, tree canopies overlap). These stands occur along stream terraces in the upper and middle reaches of moderately-sized riverine systems. The riparian overstory is mixed, with arroyo willow (*Salix lasiolepis*), Fremont cottonwood, red willow (*Salix laevigata*), and California walnut (*Juglans californica* var. *californica*) dominant in many riverine systems in the central and southern portions of the State, particularly in the perennial reaches, such as at the East Fork of San Luis Obispo Creek on the SLO Tank Farm site.

The understory of the riverine systems of the biogeographic region of central coastal California supports a mix of native and nonnative plant species. Understory shrubs occurring on creek banks include coyote brush (*Baccharis pilularis*) and California sage (*Artemisia californica*) where the canopy is open, and blackberries (California blackberry [*Rubus ursinus*] and Himalayan blackberry [*Rubus discolor*]) in both sun and shade. Herbaceous species occurring in the riparian corridor (*i.e.*, vegetation adjacent to, and influenced by, the presence of moving water) include mugwort (*Artemisia douglasiana*), poison hemlock (*Conium maculatum*), smilo grass (*Piptatherum miliaceum*), wild oats (*Avena barbata*, *A. fatua*), and Italian thistle (*Carduus pycnocephalus*).

In the less disturbed stream reaches in this geographic region, typically higher in the watershed than the SLO Tank Farm site, large oaks are joined by white alder (*Alnus rhombifolia*) and western sycamore as dominants, particularly immediately adjacent to the stream channel. In addition to these tree species, the riparian plant communities consist of a small suite of native shrubs and vines found in the understory. Poison oak (*Toxicodendron diversiloba*) is ubiquitous, as is California blackberry. Less common, but still frequently occurring in the shrub layer, are several species of gooseberry (*Ribes* spp.) and honeysuckle (*Lonicera* spp.). These taxa are critically important food sources for the native fauna, providing a varied and abundant source of berries throughout much of the year. In the low elevation coastal plain, willows and California walnut are prominent in the lowland riparian ecosystems. Native oak savannah/bunch grass mosaic is the reference standard condition in upland areas along the riparian corridor.

Invasion by exotic species is a significant concern in California. Many ecosystems, particularly waters/wetlands in the region are now completely devoid of a native complement of vascular plants. Instead, a large suite of exotic Eurasian weeds (*e.g.*, *Bromus diandrus*, *Carduus pycnocephalus*, *Melilotus officinale*, *Piptatherum miliaceum*, *Sonchus oleraceus*), ornamental escapes (*e.g.*, *Delawarea odorata* [*Senecio mikanioides*], *Tropaeolum majus*, *Vinca major*, *Eucalyptus globulus*), or a various planted ornamentals, dominant a variety of plant communities across California's landscapes.

B. Vascular Plants of SLO Tank Farm

One hundred fifty-two (152) vascular plant species have been identified within the property boundaries of the SLO Tank Farm. This listing combines previous field surveys (EDAW 1999, Jenesis 2003, Rincon 2003-2004) as well as recent surveys by the Padre/WSP project team (Padre 2007, 2008; Padre & WSP 2008). A complete list of plant species identified in SLOTF is provided as Appendix A. Plant nomenclature follows Hickman (1993), with the exception of the Cyperaceae, which follows the Flora of North America, Volume 23 (FNA 2002).

Forty-nine percent (49%; 74 taxa) vascular plant species are native taxa, while 51% (78 taxa) are non-native (primarily naturalized) species commonly represented in the California flora. The percentage of non-native taxa on the SLO Tank Farm is more than twice that calculated for the State as a whole (approximately 20% [Randall, Rejmánek, and Hunter [1998] as cited in Bossard and Randall 2007]), reflecting a relatively high level of site disturbance associated with past oil operations, maintenance, and abandonment, and past and continued cattle grazing.

Seven species are of concern to the conservation community (Table 1). None of these species are protected under the federal Endangered Species Act of 1973, as amended, nor under the California Endangered Species Act. Rather, they have been identified by the California Native Plant Society as species in decline (see Section IV), and are therefore acknowledged under the California Environmental Quality Act as significant biological resources of the SLO Tank Farm.

Table 1. Plant species of conservation concern, their protected status, and approximate areas (acres) at the SLO Tank Farm Project Site, San Luis Obispo, California.

Scientific Name	Common Name	Protected Status	Area (acres)
<i>Calystegia subacaulis</i> ssp. <i>episopalis</i>	Cambria morning glory	CNPS 1B.2*	14.2
<i>Castilleja densiflora</i> ssp. <i>obispoensis</i>	San Luis Obispo owl's clover	CNPS 1B.2	10.6
<i>Centromadia parryi</i> ssp. <i>congdonii</i>	Congdon's tarplant	CNPS 1B.2	25.9
<i>Dudleya abramsii</i> ssp. <i>bettinae</i>	San Luis Obispo serpentine dudleya	CNPS 1B.2	0.04
<i>Eryngium aristatum</i> var. <i>hooveri</i>	Hoover's button-celery	CNPS 1B.1	0.17
<i>Juglans californica</i>	Southern California walnut	CNPS 4.2	N/A***
<i>Nassella pulchra</i>	Purple Needlegrass	CNDDDB**	11.5

*CNPS = California Native Plant Society

1B = Plants rare, threatened, or endangered in California and elsewhere

0.1 = seriously endangered in California

0.2 = fairly endangered in California

**CNDDDB = California Natural Diversity Database "special community"

***42 Southern California walnut trees are located along the East Fork of San Luis Obispo Creek; area of southern California walnut habitat was not calculated.

C. Vegetation Classification at SLO Tank Farm

1. Rationale Support Classification of SLO Tank Farm Plant Communities

Several surveys have been conducted by Padre at the Tank Farm Property for the purpose of habitat characterization and identification of jurisdictional wetlands. Rincon (2003-04) developed a “plant community map” with mapping units not grounded in any specific classification system. This report has updated the Rincon map, and offers plant communities grounded to several current vegetation schemes, including those specific to wetlands.

However, vegetation at the SLO Tank Farm project site is highly graded, rendering vegetation classification schemes for California native vegetation developed over the last century not readily applicable. For example, in the mid 1980s, California Polytechnic State University professors V. L. Holland and D. J. Keil developed a vegetation classification scheme for California, which was updated in 1995. Also during the mid-1980s, Dr. Robert F. Holland developed a draft classification of “terrestrial natural communities” as part of an effort by the California Department of Fish & Game (CDFG) to describe the vegetation of the State. This classification, while never finalized, has been the most widely used for terrestrial systems since it was developed; it is based structurally as well as philosophically in the landmark unpublished Cheatham and Haller (1975) classification.

In the early 1990s, CDFG initiated a second classification effort that deviated structurally from all other classifications (Sawyer & Keeler-Wolf 1995). This classification system has not been widely embraced by the California botanical community, in large part because it is not easy to use, and in part because, in its current published edition, wetland communities are not described comprehensively (Ferren, Fiedler & Leidy 1996). The Sawyer/Keeler-Wolf classification currently is undergoing revision, and is not yet available as a revised system. As such, upland plant communities at the SLO Tank Farm are classified using the Holland classification system, while the waters/wetlands plant communities are classified using the Ferren, Fiedler, Leidy (1996) classification developed for waters/wetlands in central and southern coastal California. The Ferren, Fiedler, Leidy (1996) classification is a regionalized version of the widely accepted U.S. Fish & Wildlife Service’s classification of wetlands and deepwater habitats (Cowardin *et al.* 1979). A thorough discussion of the waters/wetlands based upon a hydrogeomorphic perspective on the SLO Tank Farm project site is found in Padre & WSP (2008).

2. Plant Communities at the SLO Tank Farm

Seven plant communities are found at the SLO Tank Farm project site. These include three (3) upland communities of non-native annual grassland, serpentine bunchgrass grassland, central (Lucian) coastal scrub. Additionally, four (4) waters/wetland communities are present, including palustrine persistent emergent vernal freshwater marsh, palustrine nonpersistent emergent vernal swale/pool, palustrine scrub-shrub broad-leaf deciduous valley stream-bank wetland, and palustrine forested broad-leaf deciduous valley stream-bank wetland (Figure 3). Additionally, two habitats not classified by Holland or Ferren, Fiedler & Leidy but support some vascular plants include a serpentinite rock outcrop that has been quarried extensively, and a ruderal class within developed portions of the site where non-native weeds have established around buildings, in asphalt cracks, and similar heavily disturbed areas.

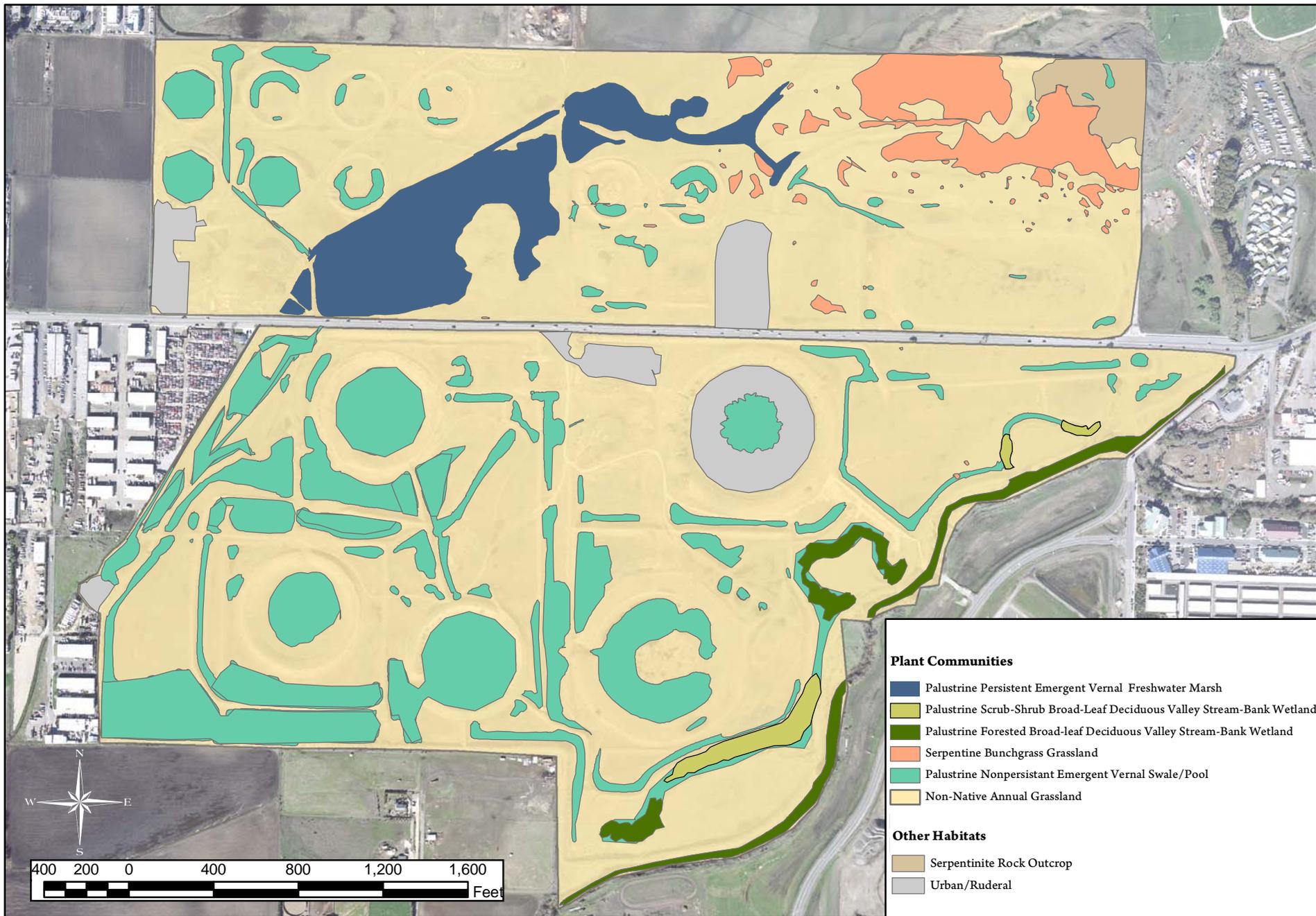


Figure 3
 Plant Communities of the San Luis Obispo Tank Farm

a. Upland Plant Communities

i. Non-Native Grassland. California annual grasslands are composed of a sparse to dense cover of various non-native, annual grasses, often interspersed with native and non-native forbs. California annual grassland communities cover most of the project site, approximately 218.6 acres, and are highly variable in their composition. Representative non-native grassland species found on-site include Italian ryegrass (*Lolium multiflorum*), soft chess (*Bromus hordeaceus*), hare barley (*Hordeum murinum* var. *leporinum*), ripgut grass (*Bromus diandrus*), and slender wild oat (*Avena barbata*). Common broad-leaved species include bird's-foot trefoil (*Lotus corniculatus*), cut-leaf plantain (*Plantago coronopus*), bristly ox-tongue (*Picris echioides*), hayfield tarplant (*Deinandra congesta* ssp. *luzulifolia*), star thistle (*Centaurea solstitialis*), and western ragweed (*Ambrosia psilostachya*) (EDAW 1999, Padre 2007).

Photograph 3. Non-Native Annual Grassland at the San Luis Obispo Tank Farm site. *In addition to non-native grasses, many non-native forbs are widespread. The light green vegetation in the center of the photograph is the exotic mayweed (Anthemis cotula).*



ii. Serpentine Bunchgrass Grassland. This community occupies approximately 11.5 acres in relatively disturbed conditions at the northeast portion of the project site, just west of the former quarry area. Like the annual grassland described above, non-native annual species, primarily slender wild oat and ripgut grass comprise a large portion of the composition, but it also supports many individuals of native purple needlegrass (*Nassella pulchra*) (ENTRIX 1998, Padre 2007). This community also supports significant populations of the Cambria morning glory.



iii. Central (Lucian) Coastal Scrub. Central (Lucian) Coastal Scrub habitat occurs in scattered locations throughout SLO Tank Farm. Dominant species within this habitat include coyote brush (*Baccharis pilularis* var. *consanguinea*) and California sagebrush (*Artemisia californica*) as well as a variety of non-native herbaceous species similar to those present in the annual grassland plant community.

Photograph 4. Central (Lucian) Coastal Scrub at the San Luis Obispo tank farm site. A highly degraded common, this shrubland is dominated by coyote brush (*Baccharis pilularis*).

b. Waters/Wetlands Plant Communities

i. Palustrine Persistent Emergent Vernal Freshwater Marsh. Numerous freshwater marsh communities exist throughout the SLO Tank Farm project site. A large area, adjacent to the north side of Tank Farm Road (North Marsh) comprises approximately 16.7 acres of palustrine persistent emergent vernal freshwater marsh. The marsh community contains several small swales due to the historical activity within the Tank Farm Property (e.g., excavation, construction of containment berms, etc.).



Photograph 5. Palustrine Persistent Emergent Vernal Freshwater Marsh (PPEVFM) at the San Luis Obispo tank farm site.

The historical activities have allowed establishment of a wide range of seasonally inundated and saturated wetlands dominated by a few (predominantly perennial) rushes, sedges, and cattail including spikerush (*Eleocharis macrostachya*), tall flatsedge (*Cyperus eragrostis*), nutsedge (*Cyperus esculentus*), common cattail, and variety of native rushes (*Juncus bufonius* var. *bufonius*, *J. phaeocephalus*, *J. tenuis*, and *J. xiphioides*), (EDAW 1999, Padre 2007). Other species observed include bulrush (*Schoenoplectus acutus*), spikerush (*Eleocharis macrostachya*), and chain speedwell (*Veronica catenata*). Tank Farm Creek supports these species as well as large stands of common cattail (*Typha latifolia*), and because it is hydrologically connected to this marsh, is included within the plant community.



Photograph 6. Swale hydrologically connected to the Palustrine Persistent Emergent Vernal Freshwater Marsh. Many vernal or semi-permanent drainages and artificial pools support native rushes, spike rushes, and sedges.

ii. Palustrine Nonpersistent Emergent Vernal Swale/Pool. Most of the small swale/pool wetlands with seasonal hydrology that are present differ from the previously described swales within the palustrine persistent emergent vernal freshwater marsh by their plant composition. These wetlands occupy a large portion of the project site, approximately 68.1 acres, and are dominated by primarily non-native widespread annual grasses and forbs, primarily because intensive site activities, including grazing, have facilitated the establishment and persistence of non-native species. Species commonly observed in these annual-dominated vernal swale/pool mosaics include saltgrass (*Distichlis spicata*), beardgrass (*Polypogon monspeliensis*), tall flatsedge (*Cyperus eragrostis*), brass buttons (*Cotula coronopifolia*), curly dock (*Rumex crispus*),

and cocklebur (*Xanthium strumarium*). Other species commonly found include bristly ox-tongue, meadow barley (*Hordeum brachyantherum* ssp. *brachyantherum*), rush (*Juncus* spp.), nut-sedge (*Cyperus esculentus*), and occasionally water plantain (*Alisma plantago-aquatica*). The rare Congdon's tarplant (*Centromadia parryi* ssp. *congdonii*) is widespread in this plant community (EDAW 1999, Padre 2007).



Photograph 7. Palustrine Non-persistent Emergent Vernal Swale/Pool at the San Luis Obispo Tank Farm Site. Many vernal or temporarily flooded drainages and artificial pools support a suite of native and non-native species, including the rare Congdon's tarplant (*Centromadia parryi* subsp. *congdonii*).

iii. Palustrine Scrub-Shrub Broad-Leaf Deciduous Valley Stream-Bank Wetland.

The abandoned ox-bow and secondary channels of the East Fork, San Luis Obispo Creek along the eastern and southern boundaries of the SLO Tank Farm support a highly degraded willow riparian community. This plant community occupies approximately 2.1 acres and is dominated by occasional stands of arroyo willow with a large and open canopy. In the understory is a varied complement of native and non-native grasses and forbs. This community may once have been a forested streambank community, but present-day grazing has led to a loss of species richness and structural complexity.



Photograph 8. Palustrine Scrub-Shrub Broad-leaf Deciduous Valley Stream-Bank Wetland at the San Luis Obispo Tank Farm Site. This community is highly degraded, with arroyo willows lining the old oxbow channels.

iv. Palustrine Forested Broad-Leaf Deciduous Valley Stream-Bank Wetland. The small reach of Acacia Creek and the East Fork, San Luis Obispo Creek that runs along the eastern and southern boundaries of the SLO Tank Farm support a variety of similarly degraded mixed riparian streambank forest. The broad-leaf deciduous riparian plant community occupies approximately 5.3 acres and is dominated by a tall, patchy canopy of western sycamore, arroyo willow, red willow, and Fremont cottonwood, with a few occurrences of eucalyptus (*Eucalyptus* spp.),

southern California walnut (*Juglans californica*), California bay (*Umbellularia californica*), and coast live oak (EDAW 1999).

c. Other Habitat Types

i. Serpentinite Rock Outcrop.

The disturbed rock outcrop (*i.e.*, former quarry site) occupies 3.3 acres in the northeastern corner of SLO Tank Farm and contains a mixture of serpentine rock outcrops along the upper slopes and clay-loam soils along the lower slopes. Areas of non-native grasses, including species described within the annual grassland habitat, as well as scattered occurrences of herbaceous species such as wild oats, common lip-pia (*Phyla nodiflora*), cudweed everlasting (*Gnaphalium luteo-album*), and red valerian (*Centranthus ruber*) exist on the lower slopes. The serpentinite rock outcrops along the upper slopes support species such as slender buckwheat (*Eriogonum elongatum* var. *elongatum*) and the special-status San Luis Obispo serpentine dudleya (*Dudleya abramsii* ssp. *bettinae*). However, the site is so disturbed and so barren it does not support enough leaf area to form a definable community type.



Photograph 9. Palustrine Forested Broad-Leaf Deciduous Valley Stream-Bank Wetland at the San Luis Obispo Tank Farm Site. *This community is highly degraded, with multi-stemmed southern California walnuts (*Juglans californica*) not uncommon on the upper slopes of the stream bank.*

ii. Ruderal/Urban. Small areas of the SLO Tank Farm are developed such as the row of low buildings and adjacent parking lot in the far western portion of the project site. Additionally, some of the tank bottoms are concrete, asphalt, degraded crude oil or a combination of these human-made substrates that restrict plant establishment. These areas occupy approximately 11.7 acres of the project site and support few plant species other than the ubiquitous non-native weeds (*e.g.*, narrowleaf plantain [*Plantago lanceolata*], Kentucky bluegrass [*Poa annua*], white sweetclover [*Melilotus alba*], *etc.*).



Photograph 10. Ruderal/Urban Habitats at the San Luis Obispo Tank Farm Site. *This community is highly degraded, dominated primarily by widespread native and non-native species. Remnant tank walls and bottoms typify this habitat.*

IV. Vascular Plant Species of Conservation Concern

Six special status species and a dominant grass species, purple needle grass, declining state wide are found at the SLO Tank Farm project site (Figure 4). As mentioned in Section II.B previously, none of these taxa are protected by federal or state law. Rather, all have been identified by the California Native Plant Society (CNPS) as rare, threatened, and endangered in California and elsewhere (List 1B). Species descriptions are summarized from Hickman (1993) and Tibor (2001).

A. Field Survey Methods

The presence, relative density, and geographic distribution of the five special status plant species were surveyed from May 13 until July 25, 2008. Purple needlegrass was surveyed from April 14 to 25, 2008, and only its geographic distribution was mapped. Spatially explicit mapping of individual population occurrences was accomplished by walking the SLO Tank Farm project site in teams of two to four botanists/field technicians, concentrating on areas of anticipated impact. Once an occurrence was identified, the geographic extent of the population was delimited with pin flags (Photograph 11). Once the population



Photograph 11. Pin flags surrounding population of San Luis Obispo owl's clover (*Castilleja densiflora* ssp. *obispoensis*).

occurrence had been adequately circumscribed, one of the Padre/WSP team members would walk the perimeter of the population with a hand-held Trimble GPS unit (GeoXT Pocket PC). Spatial data (point and polygon features) were stored during the field day in the Trimble unit but downloaded nightly for GIS mapping using the GPS Pathfinder 3.10 mapping software.



Photograph 12. Member of Padre/WSP field team collections population collection density data for the Cambria morning glory (*Calystegia subacaulis* ssp. *episcopalis*).

To obtain a rough estimate of population density, one of the Padre/WSP team members walked the extent of each population occurrence and at every ten paces, randomly threw a 20 x 50 cm sampling frame and then recorded the number of individuals rooted with the 100 cm² plot (Photograph 12). The field team repeated this population estimation procedure until an adequate sample was obtained – *i.e.*, either for every population occurrence or for a minimum of 100 sampling points.



Figure 4
Geographic Distribution of Rare Plant Species
at the San Luis Obispo Tank Farm

B. Vascular Plant Species of Conservation Concern at the SLO Tank Farm Project Site

1. Cambria Morning Glory (*Calystegia subacaulis* H. & A. subsp. *episcopalis* Brummitt) (Convolvulaceae)

The Cambria morning glory is a perennial more or less prostrate herb with a rhizome or woody stem (caudex), restricted to dry, open grasslands or scrublands of San Luis Obispo County from sea level to 500 m (Photograph 13). Leaves are typically triangular to arrowhead-shaped, up to 4 cm long, with sparse or inconspicuous hairs. Flowers are a typical morning glory shape, white or cream-colored; petals are approximately 6 cm long. It is distinguished from the type subspecies by its relatively larger bractlets (pair leaflets below the calyx), and overall lack of (appressed) hairs, although some specimens may be difficult to differentiate. Flowers bloom in the spring, with a prime blooming period of April through June. It is threatened by alteration of fire regimes, development, feral pigs, grazing, military activities, non-native plants, vehicles, and pipeline construction.



Photograph 13. Cambria morning glory (*Calystegia subacaulis* ssp. *episcopalis*) at the SLO Tank Farm project site. *Top:* Habit. *Bottom:* Flower

At the SLO Tank Farm project site, Cambria morning glory is widespread, primarily across the non-native grassland and serpentine bunchgrassland (Figure 4). It occupies 14.2 acres and can be found in varying densities (Figure 5). Most populations had few individuals in 100 cm² plots.

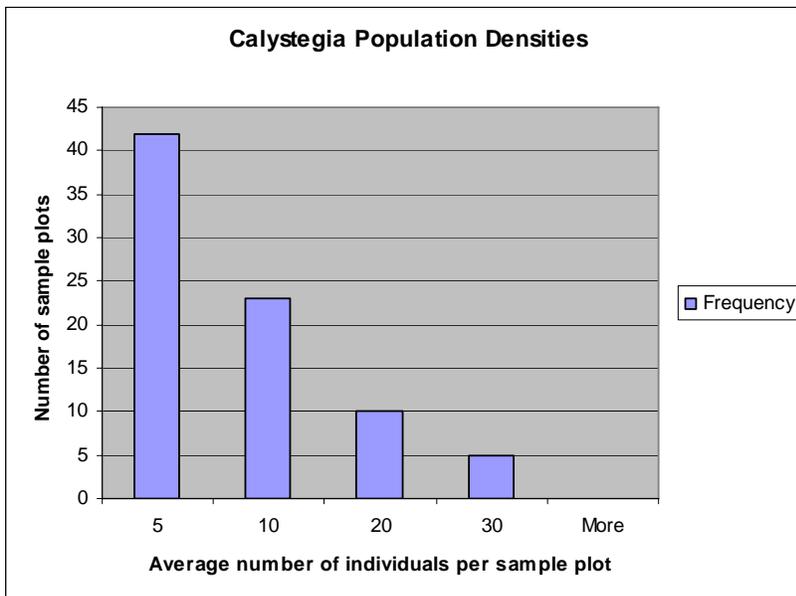


Figure 5. Frequency of Cambria morning glory individuals per sample plot at the SLO Tank Farm project site.

2. San Luis Obispo Owl's Clover (*Castilleja densiflora* (Benth.) Chuang & Heckard subsp. *obispoensis* (Keck) Chuang & Heckard) (Scrophulariaceae)

The San Luis Obispo owl's clover is a local variant of a wide spread, native annual wildflower (Photograph 14). Many flowers per inflorescence are borne on a single stem, often branched. Flowers are subtended by taxonomically important bracts, and in this subspecies, they are equal in size to the flowers and white or pale yellow (as opposed to purplish or white). It is restricted to grasslands in San Luis Obispo County less than 100 m elevation, and blooms between March and May.

San Luis Obispo owl's clover can be distinguished from other infraspecific owl's clover by the color and relatively larger size of its calyx lobes and inflorescence and shape of corolla lip. Hickman (1993) acknowledges that this is a highly variable taxon with many local variants that are in need of clarification. This rare owl's clover is threatened by habitat degradation (grazing) and loss (development).

On the SLO Tank Farm site, this rare species is widespread in the non-native grassland plant communities, occupying 10.6 acres. However, color forms that key to both the widespread taxon and the local endemic are found here, and in many cases, it is not always possible to distinguish between the two. Dr. Margriet Wetherwax, the taxon expert (and family editor) for *The Jepson Manual, Second Edition* (TJM Editorial Committee [in preparation]) will recognize the current taxonomy in the second edition, but acknowledges that the delimitation among the infraspecific taxa is imprecise and difficult in the field (Wetherwax personal communication to Fiedler 2008). In the southern portion of the project site, San Luis Obispo owl's clover tends to favor the decaying concrete rim of Reservoir 3, and the grasslands in the northeast portion of the site south of Tank Farm Road. Despite its relatively diminutive stature and comparative small size, few individuals (<5) were found in 100 cm² sample plots (Figure 6).



Photograph 14. San Luis Obispo Owl's Clover (*Castilleja densiflora* ssp. *obispoensis*) at the SLO Tank Farm project site. *Top:* Habit. *Bottom:* Flower

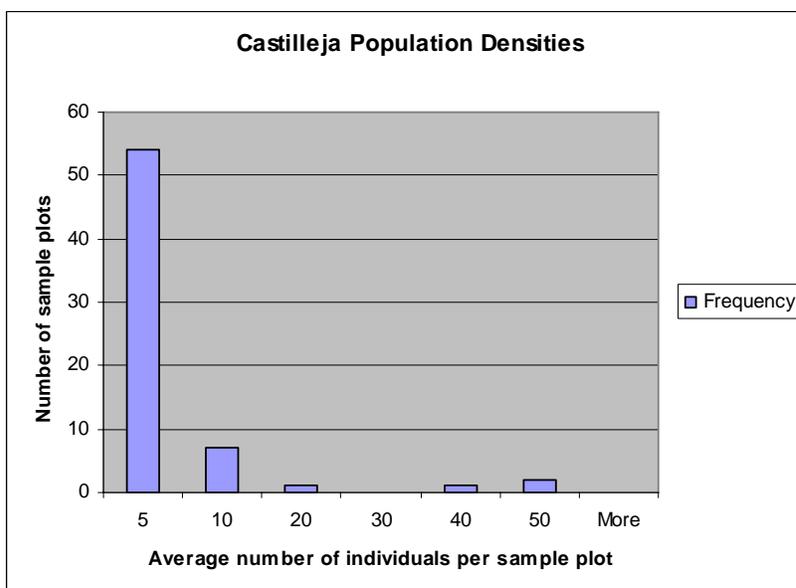


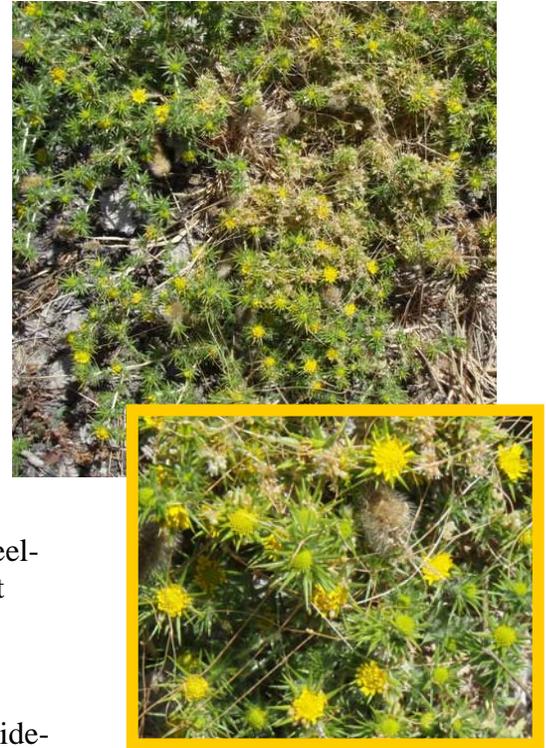
Figure 6. Frequency of San Luis Obispo Owl's Clover individuals per sample plot at the SLO Tank Farm project site.

3. Congdon's Tarplant (*Centromadia parryi* (Greene) Greene subsp. *congdonii* (B. L. Rob. & Greene.) B. G. Baldwin) (Asteraceae)

As currently circumscribed, only four species are recognized (Baldwin 2003), and all are self-incompatible annuals or rhizomatous herbs with sharp, spine-tipped leaves, often occurring in seasonally saturated, often alkaline substrates.

Congdon's tarplant is a mildly scented annual that varies considerably in size, from less than 1 to 7 dm (Photograph 15). This tarplant also can be erect or prostrate, and unlike other tarplants, is not adorned with glands or small hairs. The inflorescence is either open or dense, and the phyllaries are keeled and spine-tipped. Disk flowers are a bright yellow, and last from May through October. It is a species that prefers valley and foothill grasslands below 230 m that are seasonally wet.

At the SLO Tank Farm site, Congdon's tarplant is the most widespread rare plant species, occupying 25.9 acres. However, typically only one individual was recorded in the 100 cm² sample plots (Figure 7). It occurs in and throughout the palustrine non-persistent vernal swales and pools, at the periphery of the palustrine persistent emergent vernal marsh, and an occasional individual can be found in the palustrine scrub-shrub wetlands.



Photograph 15. Congdon's tarplant (*Centromadia parryi* subsp. *congdonii*) at the SLO Tank Farm project site. *Top:* Habit. *Bottom:* Flower

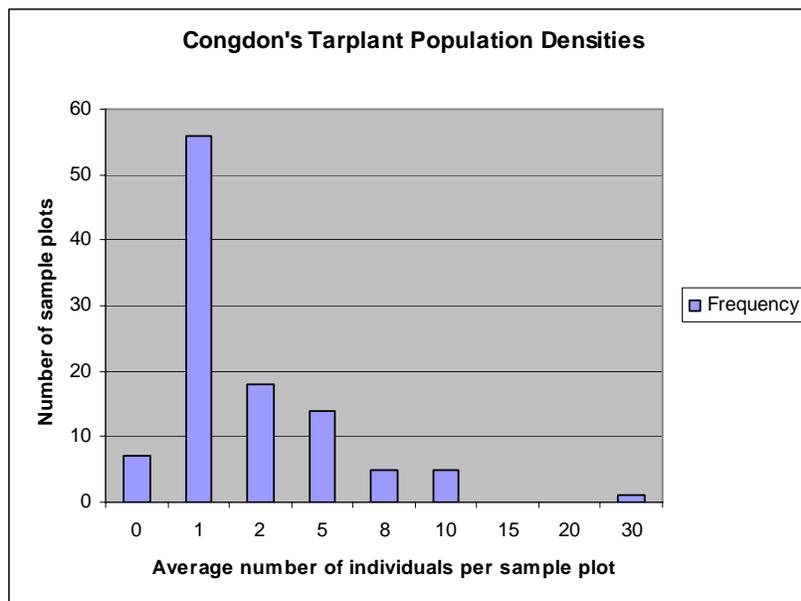


Figure 7. Frequency of Congdon's tarplant individuals per sample plot at the SLO Tank Farm project site.

4. San Luis Obispo Serpentine Dudleya (*Dudleya abramsii* Rose ssp. *bettinae* (Hoover) J. Bartel) (Crassulaceae)

The San Luis Obispo serpentine dudleya is a native succulent restricted to serpentinite substrates in San Luis Obispo County. It has a variable stem width, from 2 – 20 mm wide and highly branched (Photograph 16). Leaves are 2-7 cm long, 2-7 mm wide, and a gray-green color. When crushed, they exude a purple dye. Individual plants form up to 40 rosettes. The inflorescence ranged in height from 5 – 25 cm, and bears a variable number of small flowers with fused petals. Pale yellow to white petals are purplish near the tips, and often with a few purple specks. It is restricted to serpentinite outcrops within the serpentinite grasslands, 50-180 m elevation. It can be distinguished from subsp. *murina* by its relatively larger leaf width cylindrical in cross section, and greater number of individual rosettes. The San Luis Obispo serpentine dudleya can be distinguished as sub sp. *abramsii*, subsp. *affinis*, and subsp. *parva* by its restriction to an ultramafic substrate.



Photograph 16. San Luis Obispo Serpentine Dudleya (*Dudleya abramsii* subsp. *bettinae*) at the SLO Tank Farm project site. *Top:* Habit. *Bottom:* Flower

At the SLO Tank Farm site, San Luis Obispo serpentine dudleya is the most restricted rare plant species, occupying only 0.04-acre. It is found only on the quarried serpentinite rock outcrop in the northeastern corner of the project site. Only a few occurrences were documented, and typically only two individuals were recorded in each 100 cm² sample plots (Figure 8).

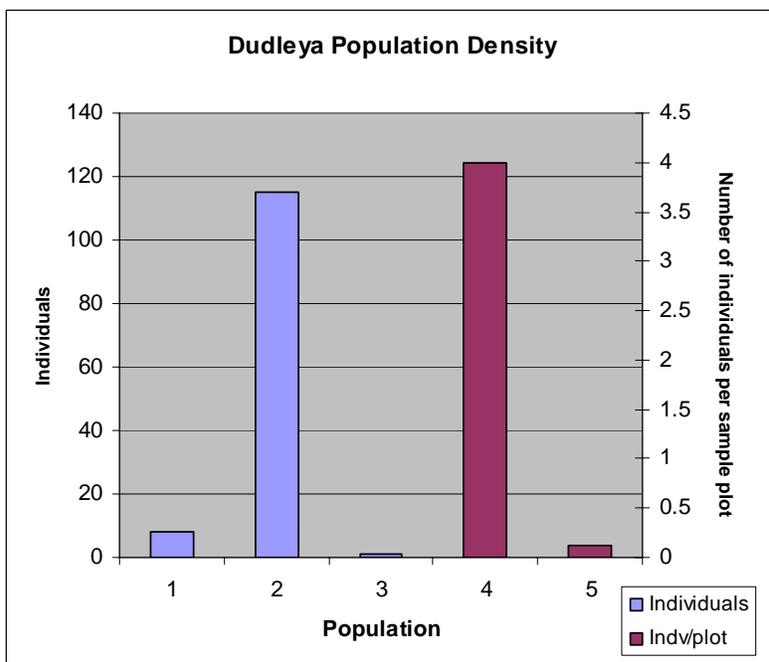


Figure 8. Frequency of San Luis Obispo Serpentine Dudleya individuals per sample plot at the SLO Tank Farm project site.

5. Hoover's Button-Celery (*Eryngium aristulatum* Jepson var. *hooveri* Y. Sheikh) (Apiaceae)

Hoover's button-celery is a biennial to perennial herb that arises from a stout, generally branching short stem. Leaves are basal, without hairs, with the petiole longer than the blade. Floral bracts and bractlets bear sharply toothed margins. Flowers are tiny (< 4mm), white (sometimes purplish), and bloom during the mid to late summer (July). The fruit is a small schizocarp bearing dense scales that are rough to the touch. Hoover's button-celery is distinguished from other infraspecific taxa in this group by its relative stout and ascending habit and its sharply toothed bractlets.

Hoover's button-celery is an uncommon native species restricted to vernal pools, ponds and swales from the southern San Francisco Bay region (*e.g.*, Alameda and Santa Clara counties) to the South Coast Ranges (San Luis Obispo County).

On the SLO Tank Farm project site, Hoover's button-celery is found in several small populations near the northern border in the eastern portion of the north parcel, as well as several small populations on the south parcel (Figure 4), occupying only 0.16-acre. It prefers palustrine nonpersistent vernal swales and pools. Based upon the 100 cm² sample plots (Figure 9), it occurs primarily as one or a few individuals.



Photograph 17. Hoover's button-celery (*Eryngium aristulatum* subsp. *hooveri*) at the SLO Tank Farm project site. *Top:* Habit. *Bottom:* Flower

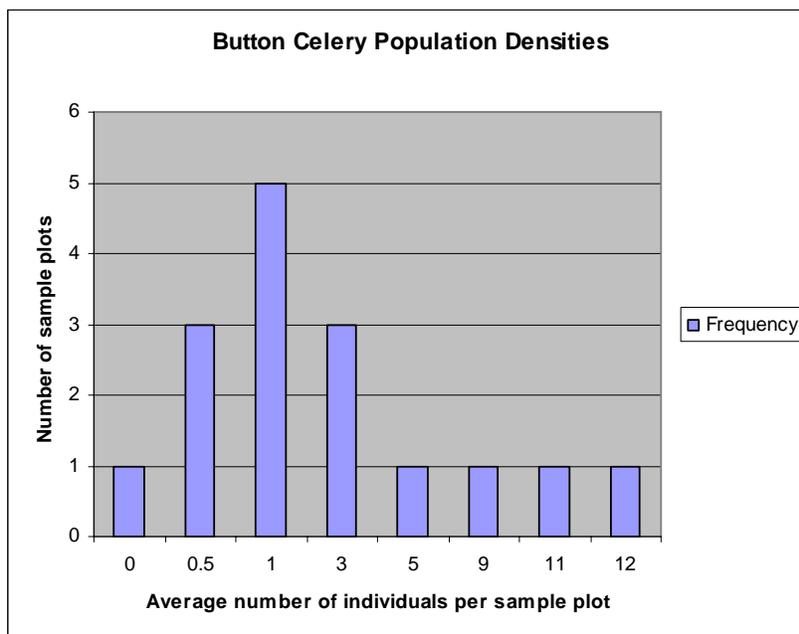


Figure 9. Frequency of Hoover's button-celery individuals per sample plot at the SLO Tank Farm project site.

C. Other Vascular Plant Species of Note

Two vascular plant species, purple needlegrass (*Nassella pulchra*) (Poaceae) and southern California walnut (*Juglans californica*) (Juglandaceae) are also found on the SLO Tank Farm project site. They are significant native plant species in part because they are functional and structural dominants in the vegetation in which they occur. Specifically, purple needlegrass is a widespread native bunchgrass while the southern California walnut is a native tree (or sometimes shrub) that forms woodlands restricted to the southern portion of the state. Both of these species dominate plant communities that are recognized by the California Department of Fish & Game (CDFG) as “special communities” (<http://www.dfg.ca.gov/biogeodata/vegcamp/>), Purple Needlegrass (community number *41.150.00) and California Walnut Woodland (community number *72.100.01). Special communities were recognized through the development of the Sawyer & Keeler-Wolf (1995) classification for the State. According to CDFG, special communities are those “that are either known or believed to be of high priority for inventory in CNDDDB [California Natural Diversity Data Base]. Lead and trustee agencies may request that impacts to these communities be addressed in environmental documents” (<http://www.dfg.ca.gov/biogeodata/vegcamp/>). Therefore, because these two species are known to occur on the SLO Tank Farm project site, we have mapped their occurrences and describe their characteristics.

1. Purple Needlegrass (*Nassella pulchra*) Grassland

Purple needlegrass is a perennial bunchgrass widespread in California west of the Sierra Nevada crest. It is one of four species of needlegrass in the State, three of which are native. Individuals range from 3 to 10 dm in height, and bear narrow leaves with leaf blades between 1 and 3.5 mm in width. The grass spikelet supports a single floret (flower), with unequal glumes subtending. The lemma is hairy between the veins, which is an important taxonomic character. The very long awn on the floret – between 38-100 mm in length, is strongly bent twice. The purplish spikelet gives this native grass its common name.

Because of its large geographic distribution, purple needlegrass often is a dominant, co-dominant or sub-dominant in many grassland and shrubland plant communities (see CDFG 2003 for further listings). A great deal is known about this native grass, including its response to grazing, multiple genotypes, quantitative traits, and propagation requirements (see Bartolome *et al.* 2007).

On the SLO Tank Farm project site, purple needlegrass is primarily found in the far northeastern portion of the site in association with the ultramafic outcrop and derivative soils. Smaller populations are found in the southern portion of the north parcel near Tank Farm Road. Purple needlegrass grassland occupies 11.5 acres at the SLO Tank Farm site.



2. California Walnut (*Juglans californica* Wats.) Woodland

The southern California walnut is a deciduous tree or shrub with separate female and male inflorescences. As a tree, it maintains a single trunk less than 25 m in height; however, it can also take the form of a shrub with up to five trunks. Bark is smooth when young, and furrowed in older stems, gray to brown in color. Leaves are odd single-pinnate, with 11-19 leaflets generally lance- or oval- shaped, and between 3 and 10 cm in length. Margins of the leaflets are toothed. Flowers are borne in pendent inflorescences (“catkins”) that appear before leaves emerge in the spring. Male catkins are many-flowered, borne on last year’s twigs, while female catkins are composed of one to three flowers and are borne at the tip of new twigs. Both male and female flowers are apetalous. Fruit is a nut which is enclosed in a more or less fleshy husk. The southern California walnut is distinguished from the northern California black walnut (*Juglans hindsii*) by its generally small fruit and southern geographic distribution.



According to the CNPS, southern California walnut is on the “watch list” – *i.e.*, List 4.2, species with a limited distribution in the State. It is further classified as 0.2 – fairly endangered in California. The state rank is S3.2, meaning that either there are 21-80 occurrences or 3,000-10,000 individuals known, OR, the southern California black walnut is known to occur across between 10,000 to 50,000 acres. CNPS states that the walnut forest is a “much fragmented, rare, and declining vegetation community.” It is known to be threatened by urbanization, grazing, invasion by non-native plants, and possibly a decline in natural recruitment processes. A further but not well documented threat is the possibly hybridization with the cultivated non-native walnuts (*e.g.*, *Juglans regia*).

Several stands of southern California walnut are found along the East Fork of San Luis Obispo Creek (Figure 4). These are small stands consisting of mature, mostly multi-stemmed specimens with a non-native annual grassland understory.

V. Impacts to Plant Species of Conservation Concern

A. Impact Discussion

Impacts to rare plant species and purple needlegrass grassland will occur as a result of excavation and backfilling activities within remediation areas, existing reservoirs, and borrow areas as well as access routes, staging/stockpile areas, and various clean-up sites. Furthermore, Chevron proposes to develop portions of the project site following completion of the remediation activities. Three areas are proposed to be developed, including the Northwest Area which is the former location of Chevron's offices (approximately 6.97 acres), the Northeastern portion including the former reservoir 4 area and former recycling facility area (approximately 60 acres), and approximately 10 acres on the southeastern corner of the project site, adjacent to the East Fork of San Luis Obispo Creek.

The following provides an overview of the estimated extent of impacts to rare plants and sensitive habitat areas as a result of project implementation. A summary of the impacts associated with each of the project components (*i.e.*, remediation and development) is provided in the following Table 2. It is important to note that impacts to rare plants were estimated based on surveys conducted in 2003 and 2008. Given that several of the rare plants species present at the project site (*i.e.*, Congdon's tarplant, Cambria morning glory, and Hoover's button-celery) are annual species and plant numbers are variable each year, it is presumed that these populations will display some deviation during subsequent growing seasons.

Table 2. Estimated impacts to rare plant species and sensitive habitat areas associated with each project component.

Species	Remediation Impacts (acres)	Development Impacts (acres)
Cambria morning glory <i>Calystegia subacaulis</i> ssp. <i>episcopalis</i>	2.45	5.57
San Luis Obispo owl's clover <i>Castilleja densiflora</i> ssp. <i>obispoensis</i>	5.69	0.00
Congdon's tarplant <i>Centromadia parryi</i> ssp. <i>congdonii</i>	9.67	0.00
San Luis Obispo serpentine dudleya <i>Dudleya abramsii</i> ssp. <i>bettinae</i>	0.04	0.00
Hoover's button-celery <i>Eryngium aristulatum</i> var. <i>hooveri</i>	0.00	0.00
Purple Needlegrass <i>Nassella pulchra</i>	6.73	4.14

Following completion of the remediation activities all disturbed areas will be restored. Restoration of the project site will impact additional rare plant populations; however, these impacts are in most cases temporary and considered self-mitigating as restoration of the site will greatly enhance the existing habitat and increase ecosystem functions. Details regarding mitigation for plants of conservation concern will be outlined in the Landscape Restoration Plan (WSP & Padre 2008).

VI. Management Recommendations for Protected Vascular Plant Species and Habitats

A. Regulatory Requirements

None of the rare vascular plant species at the SLO Tank Farm site are protected under federal or state endangered species statutes (*i.e.*, Endangered Species Act of 1973, as amended, and the California Endangered Species Act). Therefore, no Section 7 consultation under the federal law will be required for any rare plant species. However, five rare plants are listed by the California Native Plant Society (CNPS) as rare in the State. In addition, purple needlegrass, dominates a native grassland community recognized by the California Department of Fish & Game as “significant” and southern California walnut is present along the East fork of San Luis Obispo Creek. The regulatory requirements of these designations are discussed below.

1. California Native Plant Society (CNPS)

The mission of the conservation program of the California Native Plant Society (CNPS), a private non-profit conservation organization, is “. . . to save native plant species and their habitats on public and private lands in California by advocating for the maximum protection of native plants and promoting science-based and ecologically-sound land management practices” (<http://www.cnps.org/cnps/conservation/>). Despite being a non-governmental organization, CNPS works in cooperation with county, state, and federal agencies, elected officials, NGOs, and other non-profit organizations to increase appreciation for and knowledge of California's native flora. Importantly, CNPS has, since 1968, developed an *Inventory* of species that are rare, threatened, declining, or are in danger of extinction through the state. Six editions of the *Inventory* of protected species have been published in book form, while a new on-line version, represents the most up-to-date information regarding the protected status of rare plants in California (<http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi>).

Five of the seven species (Cambria morning glory, Congdon’s tarplant, San Luis Obispo’s owl’s clover, San Luis Obispo serpentine dudleya, and Hoover’s button-celery) are listed by the California Native Plant Society as List 1B, *i.e.*, species rare, threatened, or endangered in California and elsewhere. Southern California walnut is also recognized by CNPS as a List 4 species - species with a limited distribution in the State.

The CNPS classification status is important because the California Environmental Quality Act, made into law in 1970, requires state and local agencies to identify significant environmental impacts of their actions, and to avoid and mitigate those impacts where feasible (California Public Resources Code §§21000-21177). Depending upon the type and extent of the project, different level(s) of environmental analysis may be required, and may take the form of an Environmental Impact Report (EIR) or Negative Declaration (ND). Further details are provided in the following discussion.

2. California Environmental Quality Act (CEQA)

The California Environmental Quality Act, CEQA, is declared in the California Public Resources Code, Sections 21000 - 21178, and Title 14 CCR, Section 753, and Chapter 3, Sections 15000 – 15387. According to the California Department of Fish Game, a state agency with some regulatory oversight under CEQA (<http://www.dfg.ca.gov/habcon/ceqa/ceqapolicy.html>):

. . . The California Environmental Quality Act (CEQA) is California's broadest environmental law. CEQA helps to guide the Department during issuance of permits and approval of projects. Courts have interpreted CEQA to afford the fullest protection of the environment within the reasonable scope of the statutes. CEQA applies to all discretionary projects proposed to be conducted or approved by a California public agency, including private projects requiring discretionary government approval.

Because one of the explicitly stated purposes of CEQA is to: “. . . [p]revent or minimize damage to the environment through development of project alternatives, mitigation measures, and mitigation monitoring”, the five CNPS-listed plant species and two sensitive habitats at the SLO Tank Farm can be expected to be protected under CEQA. Further, “. . . [f]ailure to comply with CEQA to provide full disclosure of information during the CEQA process, which would result in relevant information not being presented to the public agency, would constitute prejudicial abuse of discretion leaving the project proponent open to possible lawsuits.” Because natural resources known to be important to the State are present at the SLO Tank Farm project site, all proposed activities will be subject to CEQA review. The following Section E outlines recommended mitigation measures to reduce potentially significant impacts to special-status plant species and sensitive habitats to less than significant.

B. Seed/Propagule Collection Strategy

Three primary considerations govern the rare plant propagule collection strategy at the SLO Tank Farm project site. They are:

1. From how many patch populations of each protected species on the SLO Tank Farm should seed be collected?
2. From how many individuals within each population should seed be collected?
3. From how many flowers or inflorescences (*i.e.*, propagules) per individual should seed be collected?

These considerations follow the basic logic laid out by Guerrant and Pavlik (1996; see also Appendix B) regarding how to obtain genetically representative collections for the establishment of new rare plant populations (cf. Table 3). Regarding concern #1, sampling from one to five populations is recommended currently by Guerrant *et al.* (2004), with the primary consideration being the degree of (genetic) difference between or among populations. Because no genetic information for each of the protected species at the SLO Tank Farm site is available, it is recommended that a conservative approach be taken. That is, seed from a minimum of five patch populations of each plant species of conservation concern be collected to start the *ex situ* collection (Figure 10). Seed from up to 10 patch populations of the more widespread species (*e.g.*, Congdon's tarplant) would be more than sufficient, and if possible, should be targeted. Therefore, we propose to focus our collection efforts at the SLO Tank Farm in those areas that will be disturbed by the remediation, waters/wetlands restoration, and development (cf. Figure 10).

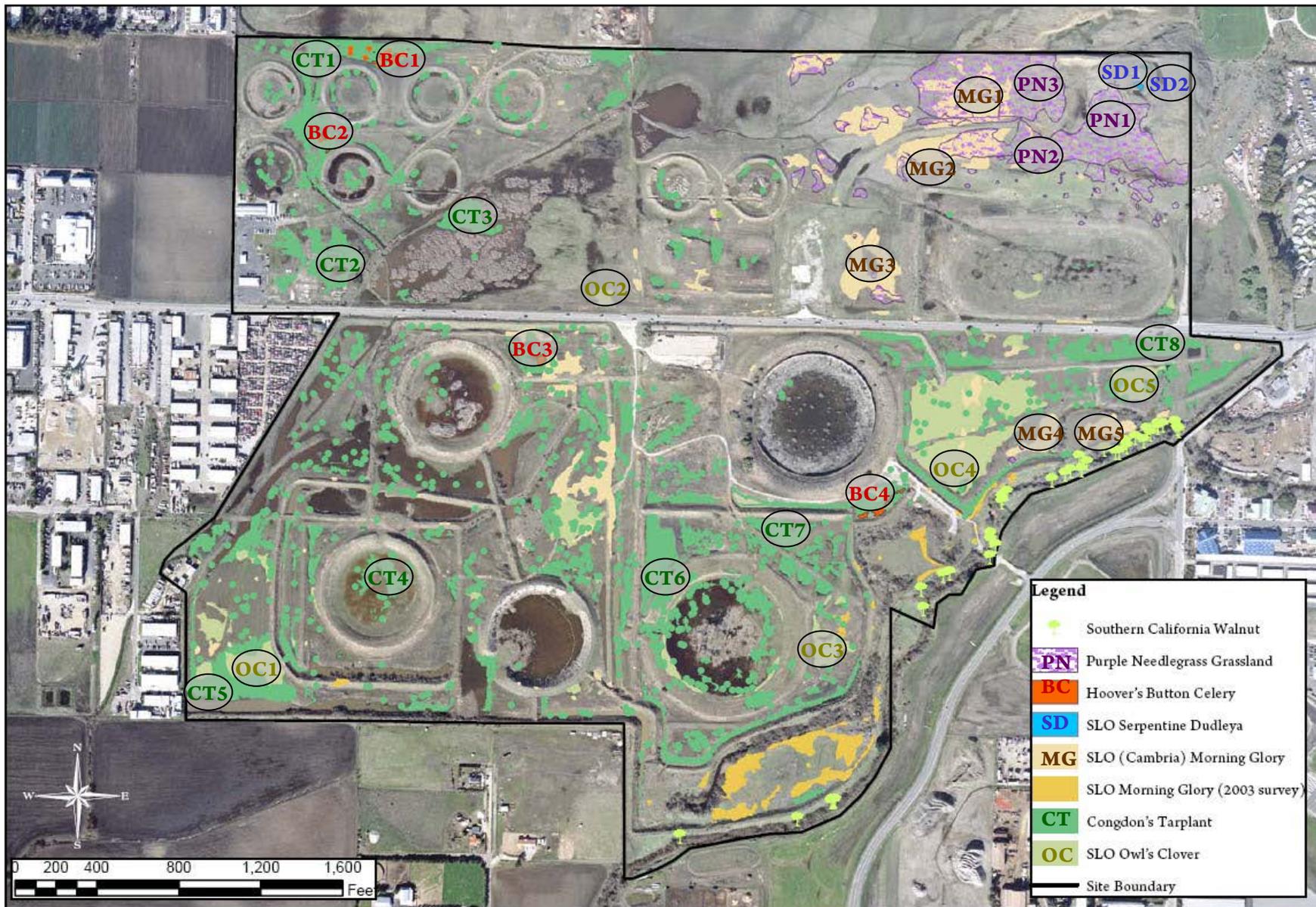


Figure 10: Proposed collection locations for protected vascular plants at the San Luis Obispo Tank Farm.

Table 3. Summary of recommended guidelines for genetic sampling for conservation collections (Table 5.1 in Guerrant & Pavlik 1998, reprinted with permission).

RARE PLANT PROPAGULE COLLECTION DECISIONS				
	Which species to collect?	How many populations per species?	How many individuals per population?	How many propagules per individual?
Recommended range	--	1-5	10-50	1-20
Target level of bio organization	Species	Ecotype and population	Individual	Allele
Key considerations	Probability of loss of unique gene pool Potential for restoration or recovery	Degree of genetic difference among populations Population history	Log of population size Genetic mobility within population	Survivability of populations Long-term use of collection
Factors affecting sampling decisions				
Collect more ↓	High degree of endangerment	High diversity/limited gene flow among populations	High diversity among individuals within each population	Low survivability of propagules
	Experiencing rapid decline	Imminent destruction of populations	Observed microsite variation	Planned use for reintroduction or restoration program
	Few protected sites	High observed ecotypic or site variation	Mixed-mating or outcrossing	
	Biological management required	Isolated populations	Fragmented historical populations	
	Recently or anthropogenically reduced	Potential for biological management and recovery	Small breeding neighborhood size	
	Feasibility of successful maintenance in cultivation or storage	Recent or Anthropogenic rarity	Low survivability of propagules	
	Possibility of reintroduction or restoration	Self-fertilization	Extremely large populations	
	Economic potential	Herbaceous annual or short-lived perennial	Boreal distribution	
		Early to mid-successional stage	Gymnosperm or dicot	
		Gravity-, explosively, or animal-dispersed seed	Woody perennial	

 <p>Collect less/fewer</p>		Dicot or monocot	Late-successional state	
		Temperate-tropical distribution	Animal or wind-disp. seed	
		Wind-dispersed seed	Temperate-tropical distribution	
		Outcrossing wind-pollinated	Early- to mid-successional stage	
		Late-successional state	Dicot	
		Observed similarity among populations	Herbaceous annual or short-lived	
		Long-lived woody perennial	Self-fertilizing	
		Gymnosperm	Explosively or gravity-dispersed propagules	
		Boreal-temperate distribution	High survivability of propagules	
		Protected populations or naturally rare	Large breeding neighborhood size	Low annual reproductive output (indicates multiyear collecting strategy)
	Closely clustered populations		High survivability of propagules	
	Low degree of endangerment	Low diversity/extensive gene flow among populations		

With respect to the second concern, again Guerrent *et al.* (2004) recommends that seed from between 10 to 50 individuals should be collected. While these may seem like a small number of samples, the allelic content is proportionate to the logarithm of both the population size and the sample size (Guerrant and Pavlik 1996), meaning that the law of diminishing returns is strong. Over a decade ago, Briggs and Brown (1991) pointed out that statistically, the first 10 individuals in any collection are as important as the following ninety. Importantly, common sense also provides reliable guidance as well, in that, if there is clear diversity in size, shape, flowering or microsite differentiation, then seed should be collected to reflect this diversity among individuals.

The third concern, how many propagules should be collected from each individual, is also guided by science as well as common sense. As with the other concerns, Guerrent *et al.* (2004) recommends between one and 20, based in large part on the expected survivorship of the propagule when outplanted in the conservation effort. Because genetic variation is best maintained when each founder individual contributes equally to the next generation (*e.g.*, Haig, Ballou, and Derrickson 1990, Templeton 1990, Guerrant 1996), it is best to keep the collection from each plant separate. That is, one can maintain equal genetic variation by keeping the propagules from each plant, which at least allows for the equalization of the female parent contribution. As pointed out by Guerrant and Pavlik (1996) it is effectively impossible to equalize the contribution of different males in the population, in part because the male parent contribution (pollen) is rarely practicable to track, and in part because the paternal fitness can vary considerably among males, as demonstrated more than twenty years ago by Schoen and Stewart (1986).

C. Propagation Recommendations

Reintroduction of rare plants and the re-establishment of self-sustaining populations has a history of mixed success, not only in California, but worldwide. Earlier efforts suffered primarily from a lack of a coherent body of theory and a scientific approach. Current reintroduction efforts have benefited from a now comprehensive understanding of the demographic processes of natural plant populations, in particular from annual and herbaceous perennial taxa. Examples of successful rare plant reintroductions can be found widely in the conservation literature, including older rare plant anthologies by Falk and Holsinger (1991), Falk, Millar & Oldwell (1996), and Guerrant, Havens & Maunder (2004), as well as large-scale single-species reintroduction projects (*e.g.*, Grewell *et al.* 2003, Pavlik *et al.* 2008).

Because of the anticipated large scale of mitigation likely to be required for the remediation, restoration, and other activities proposed for the SLO Tank Farm, it is recommended that a native plant nursery be constructed to supply a significant proportion of the nursery stock. Ms. Betty Young, Program Director for the Golden Gate National Parks Nurseries, is a well-recognized leader in the State in the propagation of native California Plants, and has written several documents that may be useful for the establishment of a native plant propagation facility for the SLO Tank Farm restoration project. Appendix C offers Ms. Young's suggestions on important considerations at the planning stages of building a native plant nursery. Appendix D offers guidelines for maintaining genetic integrity on restoration sites, and Appendix E is a comprehensive nursery safety manual for ensuring work safety in a work environment with a variety of safety hazards.

In addition to a native plant nursery, we offer the following four suggestions for successful, cost effective native plant propagation.

1. Propagate plant materials between 18 months and two years prior to outplanting allows sufficient time for collection, and doubling (or more) of collected materials. The costs of construction and maintenance of a nursery facility provides significant cost savings in acquisition of nursery stock.
2. Collect as much source material as possible. This will allow the operation to increase stock to an inventory sufficient to meet the restoration design at the time of outplanting.
3. Healthy root growth in the nursery is key to survivorship of outplanted stock.
4. A volunteer work force will be insufficient to meet the daily demands of plant propagation (*e.g.*, watering, repotting, pest control, *etc.*) for medium or large-scale operations. A full-time trained horticulturalist likely will be required to oversee and manage the nursery.

D. Measuring Success

Pavlik's comprehensive work on rare plant reintroductions, including defining success, remains the hallmark of science-based rare plant restoration work (*e.g.*, Pavlik 1994, 1995, 1996, 2008). In particular, Pavlik's science-applied research points out the testing of management-oriented hypotheses, specifically, developing a management plan that directly identifies both intrinsic and extrinsic factors that limit population establishment, growth, or persistence. Once identified, reasonable, cost-effective remedies can be implemented for the reestablished populations in the field.

Of critical importance to the management program for the five rare species at the SLO Tank Farm, will be the development of detailed species-specific monitoring programs that address four major goals (Pavlik 1996). These are population abundance, geographic extent, population resilience, and population persistence. Pavlik also emphasized that both short and long-term objectives be developed and explicitly articulated in the comprehensive monitoring program. For example, a short term objective is persistence of 85% or greater of the outplanted propagules in the new population. Alternatively, a long term objective would be the achievement of a viable population size by recruitment from a later generation cohort of seed produced by outplanted or second generation individuals. As cogently discussed by Guerrant and Pavlik (1996: 102), "... a careful delineation of objectives also helps define the monitoring program so that crucial parameters for determining success are not missed or ignored."

E. Recommended Mitigation Measures

As part of the remediation and development plans, impacts to rare plant species and sensitive habitat areas shall be avoided or minimized to the greatest extent feasible. However, impacts will occur due project implementation. Therefore, it is recommended that the following measures be implemented during project activities to reduce impacts to plant species of conservation concern. Details regarding on-site mitigation areas will be outlined in the Landscape Restoration Plan (WSP & Padre 2008).

1. General Measures

- All equipment staging areas, construction-crew parking areas, and equipment access routes will be established in previously disturbed or developed areas.
- Exclusionary fencing will be erected at the boundaries of remediation/construction areas to

avoid equipment and human intrusion into adjacent habitats. The exact location of exclusionary fencing for each area will be determined by an on-site biological monitor. The fencing will remain in place throughout each individual project component (i.e., remediation phase and development phase).

- The on-site biological monitor will conduct a worker orientation for all construction contractors (site supervisors, equipment operators and laborers) that emphasizes the presence of special-status species within the project site, identification, their habitat requirements, and applicable regulatory policies and provisions regarding their protection, and measures being implemented to avoid and/or minimize impacts.
- A dust control program during both the remediation phase and the re-development phase of the project will be implemented to minimize dust impacts to adjacent vegetation communities and rare plant species.
- A Storm Water Pollution Prevention Plan (SWPPP) will be prepared and implemented. At a minimum, erosion control measures (e.g., silt fencing, hay bales, straw wattles, etc.) will be installed along the perimeter of all work areas located in the vicinity of sensitive resources (e.g., rare plant populations, seasonal and perennial wetlands, etc.) to prevent runoff and associated sedimentation impacts into sensitive resources including Tank Farm Creek, Acacia Creek, and the East Fork of San Luis Obispo Creek.
- During remediation and construction activities, washing of concrete, paint, or equipment and refueling and maintenance of equipment will occur only in designated areas. Hay bales, sandbags, and sorbent pads will be available to contain contaminated water and/or spilled fuel to prevent migration into nearby sensitive habitat areas.
- Construction equipment will be inspected by the operator on a daily basis to ensure that equipment is in good working order and no fuel or lubricant leaks are present.

2. *Protective Measures for Special-Status Plants*

- Due to the fluctuation in annual plant populations (i.e., Congdon's tarplant, Hoover's button-celery, San Luis Obispo owl's clover), botanical surveys will be conducted by a City/County-approved biologist prior to implementation of each phase of the project. The purpose of these surveys is to provide up-to-date locational information for each special-status plant species population within areas of anticipated impacts prior to construction. Fluctuations in populations will be added cumulatively to the current distribution map (i.e., all newly discovered populations will be added to existing populations documented in previous years). All mapped populations will be clearly fenced off with exclusionary fencing prior to remediation or construction activities in those areas. If areas supporting rare plant species are determined by the City/County to be unavoidable then seed will be collected from selected plants in impact areas and utilized to restore habitat within pre-designated restoration areas on-site.
- The final remediation and development plans will clearly illustrate the location of all rare plant populations and wetland habitats to remain within 50 feet of remediation/construction activities. Prior to any remediation/construction or ground disturbance all work areas and the proposed construction staging area(s) will be fenced and adjacent sensitive habitats will be clearly marked with visible flagging and/or orange protective fencing for protection.

Impacts to rare plant populations (e.g., Congdon's tarplant, Cambria morning glory, Hoover's button-celery, San Luis Obispo owl's clover, San Luis Obispo serpentine dudleya, southern

California walnut, and purple needlegrass grassland) will be mitigated in-kind, resulting in no net loss of rare plant populations. Rare plant restoration areas will be monitored by a qualified biologist and maintained in perpetuity. The Landscape Restoration Plan (WSP & Padre 2008) will include specific details regarding restoration sites, monitoring schedule, maintenance, and performance criteria.

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Appendix A
Vascular Plant Species of the Chevron SLO Tank
Farm, San Luis Obispo, California

Appendix A
Vascular Plant Species of the Chevron
San Luis Obispo Tank Farm, San Luis Obispo County, California

Scientific Name	Common Name	Habit	Wetland Indicator		Family	Non-Native? Yes=1, No=0
			Status			
<i>Acacia melanoxylon</i> *	Blackwood acacia	T	.		Fabaceae	1
<i>Acacia decurrens</i>	Green wattle	T	.		Fabaceae	1
<i>Agapanthus africanus</i> *	Lily of the Nile	PH	.		Liliaceae	1
<i>Agrostis viridis</i> * [<i>A. semiverticillata</i>]	Water bentgrass	PG	OBL		Poaceae	1
<i>Alisma plantago-aquatica</i>	Water plantain	PH	OBL		Alismataceae	0
<i>Ambrosia psilostachya</i>	Western ragweed	PH	FAC		Asteraceae	0
<i>Anagallis arvensis</i> *	Scarlet pimpernel	AH	FAC		Primulaceae	1
<i>Anthemis cotula</i> *	Mayweed	AH	FACU		Asteraceae	1
<i>Artemisia californica</i>	California sagebrush	S	.		Asteraceae	0
<i>Artemisia douglasiana</i>	Mugwort	PH	FACW		Asteraceae	0
<i>Asclepias fascicularis</i>	Narrow-leaf milkweed	PH	FAC		Asclepidaceae	0
<i>Atriplex semibaccata</i>	Australian saltbush	PH	FAC		Chenopodiaceae	1
<i>Avena barbata</i> *	Slender wild oat	AG	.		Poaceae	1
<i>Baccharis pilularis</i> [<i>B.p. var. consanguinea</i>]	Coyote brush	S	.		Asteraceae	0
<i>Bellardia trixago</i> *	Mediterranean linseed	AH	.		Scrophulariaceae	1
<i>Brachypodium distachyon</i> *	False brome	AG	.		Poaceae	1
<i>Brassica nigra</i> *	Black mustard	AH	.		Brassicaceae	1
<i>Briza minor</i> *	Little quaking grass	AG	FACW-		Poaceae	1
<i>Bromus diandrus</i> *	Ripgut grass	AG	.		Poaceae	1
<i>Bromus hordeaceus</i> *	Soft chess	AG	FACU-		Poaceae	1
<i>Bromus madritensis ssp. rubens</i> *	Red brome	AG	NI		Poaceae	1
<i>Calandrinia ciliata</i>	Red maids	AH	FACU*		Portulacaceae	0
<i>Calystegia macrostegia ssp. intermedia</i>	Morning-glory	PH	.		Convolvulaceae	0
<i>Calystegia subacaulis ssp. episcopalis</i>	San Luis Obispo morning-glory	PV	.		Convolvulaceae	0
<i>Carduus pycnocephalus</i> *	Italian thistle	AH	.		Asteraceae	1
<i>Carthamus lanatus</i> *	Distaff thistle	AH	.		Asteraceae	1
<i>Castilleja densiflora ssp. densiflora</i>	Denseflower Indian paintbrush	AH	.		Scrophulariaceae	0
<i>Castilleja densiflora ssp. obispoensis</i>	San Luis Obispo owl's clover	AH	.		Scrophulariaceae	0
<i>Centaurea calcitrapa</i> *	Purple star-thistle	AH	.		Asteraceae	1
<i>Centaurea melitensis</i> *	Tocalote	AH	.		Asteraceae	1
<i>Centaurea solstitialis</i> *	Yellow star-thistle	AH	.		Asteraceae	1
<i>Centranthus ruber</i> *	Red valerian	PH	.		Valerianaceae	1

Appendix A
Vascular Plant Species of the Chevron
San Luis Obispo Tank Farm, San Luis Obispo County, California

Scientific Name	Common Name	Habit	Wetland Indicator		Family	Non-Native? Yes=1, No=0
			Status			
<i>Centromadia parryi</i> ssp. <i>congdonii</i> [<i>Hemizonia parryi</i> ssp. <i>congdonii</i>]	Congdon's tarplant	AH	FAC		Asteraceae	0
<i>Chamomilla suaveolens</i> *	Pineapple weed	AH	.		Asteraceae	1
<i>Chenopodium californicum</i>	California goosefoot	PH	.		Chenopodiaceae	0
<i>Cichorium intybus</i>	Chicory	PH	.		Asteraceae	1
<i>Cirsium vulgare</i> *	Bull thistle	BH	FAC		Asteraceae	1
<i>Conium maculatum</i> *	Poison hemlock	BH	FACW		Apiaceae	1
<i>Convolvulus arvensis</i> *	Bind weed	PV	.		Convolvulaceae	1
<i>Conyza canadensis</i> [var. <i>canadensis</i>]	Horseweed	AH	FAC		Asteraceae	0
<i>Cotula coronopifolia</i> *	Brass buttons	PH	OBL		Asteraceae	1
<i>Crassula connata</i>	Pygmy weed	AH	.		Crassulaceae	0
<i>Cuscuta</i> sp.	Dodder	AV	.		Cuscutaceae	0
<i>Cynara cardunculus</i> *	Artichoke thistle	PH	.		Asteraceae	1
<i>Cynodon dactylon</i> *	Bermuda grass	PG	FAC		Poaceae	1
<i>Cyperus eragrostis</i>	Tall flatsedge	PH	FACW		Cyperaceae	0
<i>Cyperus esculentus</i>	Nutsedge	PH	FACW		Cyperaceae	0
<i>Danthonia californica</i> var. <i>americana</i>	California oatgrass	PG	FACW		Poaceae	0
<i>Deinandra fasciculata</i> [<i>Hemizonia fasciculata</i>]	Fascicled tarweed	AH	.		Asteraceae	0
<i>Dipsacus sativus</i> *	Fuller's teasel	BH	NI		Dipsacaceae	1
<i>Distichlis spicata</i>	Saltgrass	PG	FACW*		Poaceae	0
<i>Dudleya abramsii</i> ssp. <i>bettinae</i>	San Luis Obispo serpentine dudleya	PH	.		Crassulaceae	0
<i>Eleocharis acicularis</i> var. <i>acicularis</i>	Needle spikerush	A/PH	OBL		Cyperaceae	0
<i>Eleocharis macrostachya</i>	Creeping spikerush	PH	OBL		Cyperaceae	0
<i>Epilobium brachycarpum</i>	Panicled willow-herb	AH	.		Onagraceae	0
<i>Epilobium pygmaeum</i>	Smooth-spike primrose	AH	.		Onagraceae	0
<i>Eriogonum elongatum</i> var. <i>elongatum</i>	Slender buckwheat	PH	.		Polygonaceae	0
<i>Erodium botrys</i> *	Storks bill	AH	.		Geraniaceae	1
<i>Erodium cicutarium</i> *	Redstem filaree	AH	.		Geraniaceae	1
<i>Eryngium aristulatum</i> var. <i>hooveri</i>	Hoover's button-celery	BH	OBL		Apiaceae	0
<i>Eschscholzia californica</i>	California poppy	AH	.		Papaveraceae	0
<i>Eucalyptus</i> sp. *	Eucalyptus	T	.		Myrtaceae	1
<i>Filago gallica</i> *	Narrowleaf cottonrose	AH	.		Asteraceae	1
<i>Foeniculum vulgare</i> *	Sweet fennel	PH	FACU		Apiaceae	1
<i>Geranium dissectum</i> *	Geranium	AH	.		Geraniaceae	1
<i>Gnaphalium luteo-album</i> *	Cudweed everlasting	AH	FACW-		Asteraceae	1
<i>Grindelia camporum</i> var. <i>camporum</i>	Gumplant	PH	FACU		Asteraceae	0
<i>Hazardia squarrosa</i>	Saw-toothed goldenbush	S	.		Asteraceae	0
<i>Heliotropium curassavicum</i>	Salt heliotrope	PH	OBL		Boraginaceae	0
<i>Hemizonia congesta</i> ssp. <i>luzulifolia</i>	Hayfield tarweed	AH	.		Asteraceae	0

Appendix A
Vascular Plant Species of the Chevron
San Luis Obispo Tank Farm, San Luis Obispo County, California

Scientific Name	Common Name	Habit	Wetland Indicator		Family	Non-Native? Yes=1, No=0
			Status			
<i>Heteromeles arbutifolia</i> [var. <i>macrocarpa</i>]	Toyon	S	.		Rosaceae	0
<i>Heterotheca grandiflora</i>	Telegraph weed	PH	.		Asteraceae	0
<i>Hirschfeldia incana</i> *	Summer mustard	BH	.		Brassicaceae	1
<i>Hordeum brachyantherum</i>	Meadow barley	PG	FACW		Poaceae	0
<i>Hordeum marinum</i> *	Mediterranean barley	AG	FAC		Poaceae	1
<i>Hordeum murinum</i> ssp. <i>leporinum</i> *	Hare barley	AG	NI		Poaceae	1
<i>Hypochaeris radicata</i> *	Rough cat's ear	AH	.		Asteraceae	1
<i>Juglans californica</i> var. <i>californica</i>	Southern California black walnut	T	FAC		Juglandaceae	0
<i>Juncus bufonius</i> var. <i>bufonius</i>	Toad rush	AH	FACW		Juncaceae	0
<i>Juncus phaeocephalus</i>	Brown-headed rush	PH	FACW		Juncaceae	0
<i>Juncus tenuis</i>	Slender rush	PH	FACW		Juncaceae	0
<i>Juncus xiphioides</i>	Iris-leaf rush	PH	OBL		Juncaceae	0
<i>Lactuca serriola</i> *	Prickly wild lettuce	AH	FAC		Asteraceae	1
<i>Lepidium nitidum</i>	Common peppergrass	AH	.		Brassicaceae	0
<i>Lolium multiflorum</i> *	Italian ryegrass	AG	FAC		Poaceae	1
<i>Lomatium utriculatum</i>	Common Lomatium	PH	.		Apiaceae	0
<i>Lotus corniculatus</i> *	Birdfoot trefoil	PH	FAC		Fabaceae	1
<i>Lotus purshianus</i> var. <i>pushianus</i> [var. <i>glaber</i>]	Pursh's lotus	AH	.		Fabaceae	0
<i>Lupinus succulentus</i>	Succulent lupine	AH	.		Fabaceae	0
<i>Lythrum hyssopifolium</i> *	Loosestrife	AH	FACW		Lythraceae	1
<i>Malvella leprosa</i>	Alkali-mallow	PH	FAC*		Malvaceae	0
<i>Marrubium vulgare</i> *	Horehound	PH	FAC		Lamiaceae	1
<i>Medicago polymorpha</i> *	Bur clover	AH	.		Fabaceae	1
<i>Melilotus alba</i> *	White sweetclover	A/BH	FACU+		Fabaceae	1
<i>Melilotus indica</i> *	Sourclover	AH	FAC		Fabaceae	1
<i>Nassella pulchra</i> [Stipa p.]	Purple needlegrass	PG	.		Poaceae	0
<i>Oxalis pes-caprae</i> *	Bermuda buttercup	PH	.		Oxalidaceae	1
<i>Parapholis incurva</i> *	Sickle grass	AG	OBL		Poaceae	1
<i>Paspalum dilatatum</i> *	Dallis grass	PG	FAC		Poaceae	1
<i>Pennisetum setaceum</i> *	Fountain grass	PG	.		Poaceae	1
<i>Pennisetum villosum</i> *	Feathertop	PG	.		Poaceae	1
<i>Phalaris aquatica</i> *	Harding grass	PG	FAC+		Poaceae	1
<i>Phyla nodiflora</i>	Common lippia	PH	FACW		Verbenaceae	0
<i>Picris echioides</i> *	Bristly ox-tongue	AH	FAC*		Asteraceae	1
<i>Plagiobothrys undulatus</i>	Popcornflower	AH	FACW+		Boraginaceae	0
<i>Plantago coronopus</i> *	Cut-leaf plantain	AH	FAC		Plantaginaceae	1
<i>Plantago lanceolata</i> *	Narrowleaf or English plantain	PH	FAC-		Plantaginaceae	1
<i>Plantago major</i> *	Common plantain	PH	FACW-		Plantaginaceae	1
<i>Platanus racemosa</i>	Western sycamore	T	FACW		Plantanaceae	0
<i>Poa annua</i> *	Annual bluegrass	A/BG	FACW-		Poaceae	1

Appendix A
Vascular Plant Species of the Chevron
San Luis Obispo Tank Farm, San Luis Obispo County, California

Scientific Name	Common Name	Habit	Wetland Indicator		Family	Non-Native? Yes=1, No=0
			Status			
<i>Polygonum arenastrum</i> * [<i>P. aviculare</i>]	Common knotweed, doorweed	AH	FAC		Polygonaceae	0
<i>Polypogon monspeliensis</i> *	Rabbitsfoot or annual beard grass	AG	FACW+		Poaceae	1
<i>Populus fremontii</i>	Fremont cottonwood	T	FACW		Salicaceae	0
<i>Potamogeton nodosus</i>	Long-leaved pondweed	PH	OBL		Potamogetonaceae	0
<i>Potentilla anserina</i>	Silverleaf	AH	OBL		Rosaceae	0
<i>Psilocarphus brevissimus</i> var. <i>brevissimus</i>	Dwarf wooly marbles	AH	OBL		Asteraceae	0
<i>Pyracantha angustifolia</i> *	Firethorn	S/T	.		Rosaceae	1
<i>Quercus agrifolia</i> var. <i>agrifolia</i>	Coast live oak	T	.		Fagaceae	0
<i>Ranunculus californicus</i>	California buttercup	PH	FAC		Ranunculaceae	0
<i>Raphanus sativus</i> *	Radish	A/BH	.		Brassicaceae	1
<i>Rhamnus californica</i>	California coffee-berry	S	.		Rhamnaceae	0
<i>Ricinus communis</i> *	Castor bean	S	FACU		Euphorbiaceae	1
<i>Rubus discolor</i> *	Himalayan blackberry	S/PV	FACW*		Rosaceae	1
<i>Rumex acetosella</i> *	Sheep sorrel	PH	FAC-		Polygonaceae	1
<i>Rumex crispus</i> *	Curly dock	PH	FACW-		Polygonaceae	1
<i>Rumex pulcher</i> *	Fiddle dock	PH	FAC+		Polygonaceae	1
<i>Salix laevigata</i>	Red willow	S/T	.		Salicaceae	0
<i>Salix lasiolepis</i> [vars. <i>bracelinae</i> & <i>sandbergii</i> ; <i>S. lutea</i> var. <i>nivaria</i> ; <i>S. tracyi</i>]	Arroyo willow	S/T	FACW		Salicaceae	0
<i>Schinus molle</i> *	Peruvian pepper tree	T	.		Anacardiaceae	1
<i>Scirpus acutus</i> var. <i>occidentalis</i>	Hard-stem bulrush	PH	OBL		Cyperaceae	0
<i>Scirpus robustus</i>	Alkali bulrush	PH	OBL		Cyperaceae	0
<i>Silene gallica</i> *	Windmill pink	AH	.		Caryophyllaceae	1
<i>Sisyrinchium bellum</i>	Blue-eyed grass	PH	FAC		Iridaceae	0
<i>Solanum douglassii</i>	Douglas' nightshade	PH	FAC		Solanaceae	0
<i>Sonchus asper</i> *	Prickly sow thistle	AH	FAC		Asteraceae	1
<i>Sonchus oleraceus</i> *	Common sow thistle	AH	NI*		Asteraceae	1
<i>Stachys bullata</i>	California hedgenettle	AH	.		Lamiaceae	0
<i>Toxicodendron diversilobum</i> [<i>Rhus diversiloba</i>]	Poison oak	S/V	.		Anacardiaceae	0
<i>Tragopogon porrifolius</i> *	Salsify, Oyster plant	B/PH	.		Asteraceae	1
<i>Trifolium fragiferum</i> *	Strawberry clover	AH	.		Fabaceae	1
<i>Trifolium hirtum</i> *	Rose clover	AH	.		Fabaceae	1
<i>Trifolium pratense</i> *	Red clover	PH	FACU+		Fabaceae	1
<i>Trifolium repens</i> *	White clover	PH	FACU+		Fabaceae	1
<i>Triticum aestivum</i> *	Common wheat	AG	.		Poaceae	1
<i>Typha latifolia</i>	Broad-leaf cattail	PH	OBL		Typhaceae	0

Appendix A
Vascular Plant Species of the Chevron
San Luis Obispo Tank Farm, San Luis Obispo County, California

Scientific Name	Common Name	Habit	Wetland Indicator		Family	Non-Native? Yes=1, No=0
			Status			
<i>Umbellularia californica</i>	California bay	S/T	FAC		Lauraceae	0
<i>Uropappus lindleyi</i>	Silver puffs	AH	.		Asteraceae	0
<i>Veronica anagallis-aquatica</i> *	Water speedwell	PH	OBL		Scrophulariaceae	1
<i>Vicia villosa</i> *	Hairy vetch	AV	.		Fabaceae	1
<i>Vicia sativa</i> ssp. <i>nigra</i> *	Narrow-leaf vetch	AV	FACU		Fabaceae	1
<i>Vulpia myuros</i> var. <i>hirsuta</i> *	Foxtail fescue	AG	FACU*		Poaceae	1
<i>Xanthium strumarium</i> [sspp./vars. <i>canadense</i> & <i>glabratum</i>]	Cocklebur	AH	FAC+		Asteraceae	0

Notes: Scientific nomenclature follows Hickman (1993) and Skinner and Pavlik (1994) for native taxa and Bailey and Bailey (1976).

Common names follow Abrams and Ferris (1960), Neihaus and Ripper (1976), and DeGarmo (1980).

An "*" indicates non-native species which have become naturalized or persist without cultivation.

Habit definitions:

AF = annual fern or fern ally.

AG = annual grass.

AH = annual herb.

AV = annual vine

BH = biennial herb.

PF = perennial fern or fern ally.

PG = perennial grass.

PH = perennial herb.

PV = perennial vine.

S = shrub.

T = tree.

Wetland indicator status (Reed 1988): OBL = obligate wetland species, occurs almost always in wetlands (>99% probability)

FACW = facultative wetland species, usually found in wetlands (67-99% probability).

FAC = facultative species, equally likely to occur in wetlands or nonwetlands (34-67% probability).

FACU = facultative upland species, usually occur in nonwetlands (67-99% probability).

+ or - symbols are modifiers that indicate greater or lesser affinity for wetland habitats.

NI = no indicator has been assigned due to a lack of information to determine indicator status.

* = a tentative assignment to that indicator status by Reed (1988).

A period "." indicates that no wetland indicator status has been given in Reed (1988).

Parentheses around an indicator status indicates the wetland status as suggested by David Magney.

Appendix B
Revised Genetic Sampling Guidelines for Conservation
Collections of Rare and Endangered Plants
(Guerrant, E. O., Jr. *et al.* 2004)

Ex Situ Plant Conservation *Supporting Species Survival in the Wild*

Edited by
Edward O. Guerrant Jr., Kayri Havens,
and Mike Maunder

Foreword by Peter H. Raven

SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL
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The Science and Practice of Ecological Restoration

James Aronson, EDITOR

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*Wildlife Restoration: Techniques for Habitat Analysis and
Animal Monitoring*, by Michael L. Morrison

Ecological Restoration of Southwestern Ponderosa Pine Forests,
edited by Peter Friederici and Ecological Restoration
Institute at Northern Arizona University

Ex Situ Plant Conservation: Supporting Species Survival in the Wild,
edited by Edward O. Guerrant Jr., Kayri Havens, and Mike Maunder

APPENDIX 1

Revised Genetic Sampling Guidelines for Conservation Collections of Rare and Endangered Plants

EDWARD O. GUERRANT JR., PEGGY L. FIEDLER,
KAYRI HAVENS, AND MIKE MAUNDER

The ultimate goal of collecting and storing seed or other plant material off site (ex situ) is to enhance the long-term survival prospects of sampled populations and species in their native habitats. The solution to this seeming paradox is that off-site samples are a means to an end—namely the continued survival of these threatened species in the wild—and not an end in themselves. Ex situ collections are most valuable when they function as a part of a more comprehensive, integrated conservation strategy to reduce the rate at which plant diversity is being lost (Falk 1987, 1990).

Insofar as we are able to maintain off-site samples in a healthy condition, two primary potential benefits emerge. First, ex situ collections reduce the probability that the sampled individuals, populations, and species will become irrecoverable. Second, off-site samples provide material for use in reintroduction, research, or other collection-related activities. Despite the potentially critical conservation value of ex situ samples, such collections have inherent risks and costs. Removing plant material from wild populations potentially reduces, however minimally, the short-term survival prospects of sampled populations. Both the potential benefits and the biological and other resource costs of gathering and maintaining ex situ collections must be included in the calculus of sampling decisions.

History and Direction of These Guidelines

The revised guidelines offered here are built on the foundation of the Center for Plant Conservation (CPC) Guidelines for Conservation Collections

of Rare and Endangered Plants (CPC 1991). The CPC guidelines, which have found wide application globally, are organized around a hierarchical series of four practical questions to be answered and finish with a concern for the potential impact collection might have on the sampled population. The questions are:

1. Which species should be collected?
2. How many populations should be sampled per species?
3. How many individuals should be sampled per population?
4. How many propagules should be collected from each individual?
5. Under what circumstances is a multiyear collection plan indicated?

The guidelines offered here represent evolutionary, not revolutionary change and attempt to incorporate new knowledge and lessons learned in the last decade. The five questions originally posed remain central to any sampling strategy for conservation collections of threatened plants. Perhaps the most obvious change is a shift in emphasis toward a more explicit evaluation of the multifaceted context in which the basic sampling questions must be addressed. The revised guidelines are organized around the following list of contextual questions to consider. They are intended to assist practitioners in the process of balancing the many factors that must be taken into account in collecting material of threatened plant taxa.

WHAT PURPOSE IS THE MATERIAL INTENDED TO SERVE?

- *What purpose(s) is a conservation collection intended to serve?* For example, many fewer propagules are needed to develop germination and cultivation protocols, and the genetic considerations are very different from those for acquiring a genetically representative sample for long-term storage or reintroduction.

WHAT MATERIAL IS AVAILABLE?

- *What is the nature of the sampling universe?* Sample sizes appropriate for a species limited to one or a few small populations are very different from those for a species known from 50 locations, each with a large population.
- *Is seed storage an option, or must samples be maintained as growing plants?* It is generally much easier and more economical to store large numbers of seeds in a seed bank than it is to maintain fewer actively growing plants in a botanic garden or other nonnative setting.

However, depending on available resources, seed storage may not necessarily be a realistic option, even for taxa with orthodox seeds.

WHAT WILL IT TAKE TO HAVE ENOUGH MATERIAL FOR USE WHEN NEEDED, AND IS THE BENEFIT WORTH THE COST?

- *What sources and magnitude of attrition in a collection might be expected during storage and later use to restore diversity to the wild?* Not all propagules collected will survive ex situ storage; indeed, some may be used to monitor their condition during storage, and of those that survive, not all propagules planted out will successfully reproduce.
- *When is the short-term danger posed by collection high enough to indicate that collection should be spread over 2 or more years?* In order for collection to be justified, the expected potential value of the sample must outweigh the short-term impact of collection. Under what circumstances might such restrictions not apply and emergency salvage collection be justified?
- *If material might be used for reintroduction, maintain seed from each maternal parent plant separate from seeds from other plants.* Unless seed from each maternal parent is kept separate during collection, it will be impossible to equalize the contribution of different parent plants in a reintroduction attempt.

We begin by reviewing the CPC guidelines (Table A1.1) and then consider in more detail the additional questions just posed. Unlike that of the original guidelines, the order of these additional questions is somewhat arbitrary. The task of determining sample size is made more difficult because these questions are interrelated, and the answer to one may affect others. The final sample size decisions are then the result of an iterative process that ends only when we are satisfied that the probability of increasing the long-term survival prospects sufficiently outweighs the short-term impact to the sampled populations. Our goal is to give conservationists a logical framework with which to decide for themselves what sample sizes are appropriate in ex situ collections by providing a series of factors for them to consider in arriving at their decisions (Table A1.1). Ultimately, an appropriate sample size is highly context dependent and must reflect simultaneously the intended purposes for which a collection is being made, the number and sizes of extant populations, and the likelihood of being able to store them off site in good condition for as long as they are needed.

The CPC Guidelines: An Overview

The Center for Plant Conservation's *Genetic Sampling Guidelines for Conservation Collections of Endangered Plants* (CPC 1991) represent the first comprehensive attempt to create general guidelines for conservation collections of threatened plants (Table A1.1). The Australian Network for Plant Conservation adapted the CPC guidelines for its own needs (Touchell et al. 1997) as part of a larger, more comprehensive statement about what is involved in germplasm conservation.

The original recommended ranges for the size of a conservation collection were designed to aid practitioners in determining how many propagules would be needed to capture a genetically representative sample of the population in question. Reflecting the state of the art at the time, the primary purpose of most collections of rare and endangered plant germplasm was amorphous and open-ended. For example, conservation collections would be "established for the purpose of contributing to the survival and recovery of a species" (CPC 1991: 225).

The experience of the last decade has shown us that the task of using ex situ samples to contribute to the survival and recovery of populations and species is both more complicated and more difficult than originally conceived (see Falk et al. 1996). In addition to external factors, such as the marked increases in what constitutes a minimum viable population, the original guidelines did not sufficiently reflect various propagule costs, which must be accounted for in advance of use. Therefore, the figures offered in the original CPC guidelines might better be viewed as minimum estimates of what should survive in a reintroduced population after some of these additional factors are taken into consideration.

Though groundbreaking, the CPC guidelines did not emerge from nothing. Rather, they drew on a variety of sources, most notably a foundational series of discussions on germplasm sampling strategies offered by A. H. D. Brown and colleagues (Marshall and Brown 1975, 1983; Brown and Briggs 1991). After the publication of the CPC guidelines, Brown and Marshall (1995) offered targets for germplasm collections in a larger and more comprehensive volume devoted to collecting plant genetic diversity (Guarino et al. 1995). Marshall and Brown (1975) suggested that the objective of a conservation collection for a genetically representative sample should be to include at least one copy of 95 percent of all alleles that occur in a (large) population at frequencies greater than 0.05 (5 percent). Brown and Marshall (1995) note that either increasing the certainty level above 95 percent or dropping the critical allele frequency below 0.05 drastically increases sam-

Summary of Center for Plant Conservation (CPC 1991) genetic sampling guidelines, to which one additional question has been added ("which community or habitat?"), along with alternative benchmark values recommended by Brown and Marshall (1995).

TABLE A1.1

Questions/Decisions	CPC recommended ranges	Target level of biological organization	Key considerations	Brown and Marshall (1995)
Which community or habitat?	n/a	Community	Selection of pioneer and colonizing species to reinstate original taxonomic composition and ecological processes	n/a
Which species?	Degree of endangerment	Species	Potential loss of unique genetic lineage, or gene pool	50
How many and which populations per species?	1-5 Degree of gene flow among populations	Ecotype, population	Degree of genetic difference among populations, population history	50
How many and which individuals per population?	1-50 Diversity among individuals within each population	Individual	Genetic communication within population, law of diminishing returns on additional samples	50
How many propagules per individual?	1-20 Survivability of propagules	Allele	Survivability of propagules, long-term use of collection	50

ple size with only marginal gains in total genetic representation. They note that a random sample of 59 unrelated gametes from a population is sufficient to achieve this objective. Their benchmark criterion of 50 individuals per population reflects this analysis. They discuss a series of factors that might increase or decrease the sample size, depending on circumstances.

In summary, although the general framework of the original CPC guidelines proved very useful in the 1990s, we perceive there to have been a growing feeling in the ex situ conservation community that the recommended ranges for collection may seriously underestimate what is needed to ensure a representative, long-term sample (Guerrant and Pavlik 1998), at least for some purposes. This concern is fueled in part because estimates of minimum viable population size have increased dramatically over the last decade (Lande 1995; Lynch et al. 1995). Thus, in addition to an increased appreciation of the challenges associated with preserving representative germplasm for use in reintroduction, we are also gaining a better understanding of the numbers needed to make a population viable and how to undertake a successful reintroduction effort.

Arriving at an Appropriate Sample Size

A complex network of interconnected factors must be considered in the process of arriving at an appropriate sample size for a conservation collection of an endangered plant species. One way to organize the network is to view it as a two-step process driven by two independent classes of factors, both of which feed into an evaluation cycle (Figure A1.1).

The major classes of input factors are the taxon being considered and the purposes for which samples are to be used. The choice of a taxon determines the sampling universe (i.e., how many populations are known and how large are they?) and also strongly influences the type of propagules that can be used. The other major driver concerns the various purposes that an ex situ collection is intended to serve. Once the taxon and purposes have been chosen, initial sample size estimates can be made. However, not all propagules collected can reasonably be expected to survive in good condition during the period of time between collection and use. Therefore, sufficient additional propagules are needed to mitigate expected attrition, and revised estimates must be made. The revised sample size estimates, taking attrition into consideration, are then evaluated for their potential impact on the sampled population. If the estimated impact is judged too great, then this additional

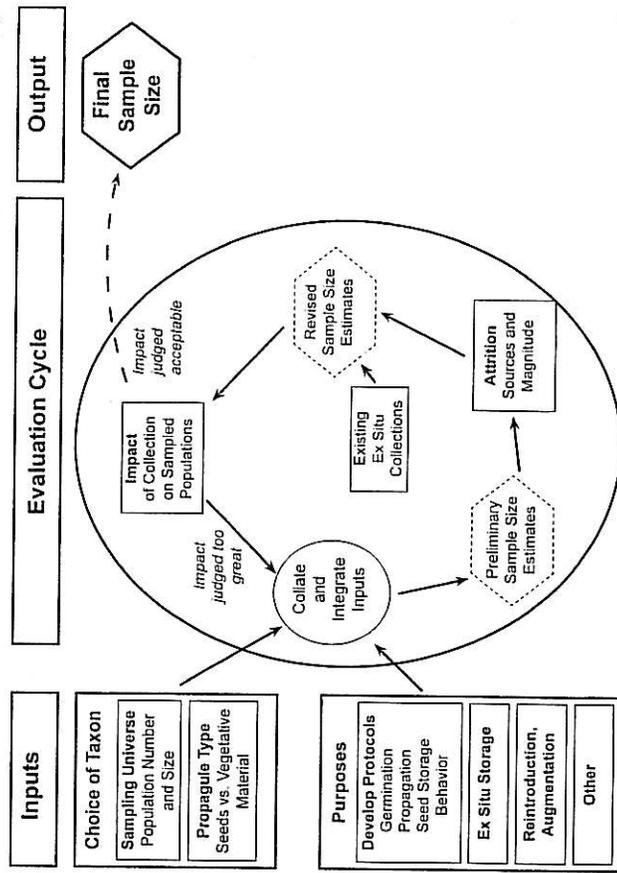


FIGURE A1.1 Conceptual flow chart illustrating how collection size decisions might be made. Illustrated are two major input factors: the choice of taxa with which to work and the purposes that collections are intended to serve. The information about taxa and purposes together are fed into an evaluation cycle that considers attrition to collections and the potential impact on sampled populations. If the impact is judged to be too great, then the evaluation cycle is repeated until the impact is judged acceptable. Refer to accompanying worksheets (Figures A1.2–A1.4).

factor is added to the sum of inputs, opportunities, and constraints, and the process of evaluating needs and impact is repeated.

Only when the perceived benefit of collection is judged to be sufficiently high and the impact on the sampled population sufficiently low is a final sample size determined.

Inputs

Two main categories of factors drive the process of determining a proper sampling design: the choice of taxon with which to work and the purposes

collections are intended to serve (Figure A1.1). Each of these two primary drivers has associated opportunities and constraints.

Choice of Taxon

In addition to the intended purpose for ex situ collections, the other major categorical input to sample size decisions is the choice of taxon. The CPC guidelines focus attention on degree of threat and the potential for loss of unique gene pools as primary determinants of which taxa are chosen for ex situ treatment, and those recommendations are still valid. In practical terms, national or more narrowly focused lists of threatened plants can be used to help prioritize taxa for collection.

The choice of a taxon establishes two sets of opportunities and constraints. One is the sampling universe: how many populations of that taxon are known, and how large are they? The other concerns our ability to store and cultivate the taxon: is seed storage an option, and, if so, how well and economically can it be stored in good condition for long periods of time, or must vegetative material be used? If vegetative material must be used, are adequate resources and personnel available to care for the material?

Sampling Universe: Number and Size of Populations

It is one thing to have an ideal target range for the number of propagules we would like to have available for use, but the actual optimal number to be collected is contingent on many factors, the foremost of which is the nature of the sampling universe. The number, size, dynamics, and threat status of known populations circumscribe the range of what can be collected.

Much of the sampling theory on which these guidelines are built was developed to inform collections of sample sizes necessary to obtain some specified likelihood of capturing alleles occurring in some specified minimum frequency, from an unspecified but large population. As noted in the original guidelines, many threatened species are found in few, often very small populations.

As grim as many gross population size figures are, often they may seriously overstate the number of individuals from which seeds can be gathered. Seeds can be gathered only from successfully reproducing plants, and not all plants in a population are reproductive.

Recommendation: For species with 50 or fewer populations, collect from as many populations as resources allow, up to all 50. For species

with more than 50 populations, collect from as many populations as is practical, up to 50.

For populations with 50 or fewer individuals, collect from all known individuals; for populations with more than 50 individuals, collect from 50.

These recommendations may appear to be absurdly high, and in many ways they are. We intend for them to represent the ideal sample meant to serve the broad range of expected purposes. These figures also assume a very large sampling universe, which is often not the case with threatened species. *In practice, therefore, sample sizes will almost always be much smaller than these benchmark guidelines, reflecting the context in which particular taxa are found, our ability to work with them, and our purposes for collecting samples.*

Before extensive collections of any one taxon are made, however, many factors must be considered, including the needs of other species. It is not necessarily desirable to finish collecting from one taxon before beginning on another. Rather, it may be better to spread collection resources over many populations of many taxa over an extended period of time. In so doing, limited resources can be allocated in a prioritized manner, focusing on the most threatened populations and species first. After initial collections of as many of the most threatened populations and taxa have been made, subsequent efforts can be made to make the collections larger and more representative. This has the added benefit of minimizing collection pressure on individual populations.

Storage Options: Seeds or Growing Plants?

Perhaps the most basic consideration in deciding how many propagules to collect concerns how effectively and economically a particular species can be maintained over time. Our ability to maintain plant material off site in a healthy condition therefore dramatically influences the collection targets. If we cannot reliably maintain material off site in good condition for long periods of time, the biological cost to sampled populations may be very high relative to the conservation value of any collection made. Therefore, a key factor in determining how much to collect concerns our ability to maintain the plant material off site.

Collection of seed for off-site storage is generally preferable to gathering plant parts or whole plants for off-site storage. There are two main arguments supporting this contention. First, seed removal is considered by many, but

not all (K. W. Dixon, pers. comm., 2001), to be less damaging demographically than is removing vegetative plant parts. This conclusion is based in part on demographic modeling by Menges (1992: 226), in which he wrote, "The threat posed to population survival by environmental variation appeared almost entirely due to variation in mortality, growth, and reproduction status and not to variation in reproductive output." Just as seed collection increases environmental variation in reproductive output, taking cuttings increases the variation in growth rate and possibly mortality. The second reason is more pragmatic. At this time, it is generally much easier and more economical and effective to store large numbers of seeds in a seed bank (assuming, of course, that such facilities are available) than it is to maintain even much smaller numbers of actively growing plants in a botanic garden or other off-site setting. Emerging technologies, such as cryopreservation of vegetative tissues (e.g., stem segments with lateral buds), when more widely evaluated and available, may provide additional storage options. However, seed storage is not necessarily a realistic option, even for taxa with orthodox seeds. If there is a choice of propagule type (seeds versus cuttings), and seeds can be stored alive for long periods of time, we believe that sampled plants and populations are much better off if seeds, rather than plant parts or, worst of all, whole plants are taken. We also acknowledge that this is not always possible or desirable. But the choice itself may require samples for viability testing, which brings us to another basic consideration, the explicit consideration of which marks perhaps the most significant development since the original guidelines. For what purpose is a sample being taken?

Purposes of a Conservation Collection

The purpose for which a collection is made strongly influences both sample size and sampling design. At one extreme, for some collection purposes, such as obtaining material to learn details of a species' germination and propagation needs or the storage behavior of its seed, little material may need to be gathered, without much regard to the genetic makeup of the collection. At another extreme, some collection purposes, such as salvaging genetic material from a doomed population for use in storage and reintroduction, may necessitate large samples taken from all individuals.

Note also that it may not always be necessary to collect additional material from the wild. For some purposes, suitable material (seeds, growing plants, or plant parts) may be available from other sources, such as existing samples in seed banks, in vitro cultures, field gene banks, or other cultivated

sources. If genetically and otherwise biologically appropriate material is available in suitable off-site storage, it may mean that new collections need not be made from wild populations.

PURPOSE: TO DEVELOP GERMINATION AND PROPAGATION PROTOCOLS OR TO DETERMINE SEED STORAGE BEHAVIOR

As a general rule, it is prudent not to collect material in volume before reliable methods are available to maintain it, given the potential negative impact of collection on sampled populations. Collection pressure can also be reduced by conducting pilot studies on closely related but more common congeners. In practice, however, there are taxa and situations for which the threat of extinction in the wild is so great that more extreme measures might be justified.

In most cases involving narrowly distributed endemic plants, it is reasonable to assume that different populations of a taxon would have similar, if not identical germination and propagation requirements and seed storage behavior. Therefore, and in the absence of obvious ecological differences between populations, there is no a priori need for a statistically representative sample, as there is, for example, in collecting for long-term storage or rare plant reintroduction. Samples collected for the latter two purposes should be taken from sources that are least likely to harm species or population survival prospects in the wild. In other words, obtain seeds (or cuttings) from the largest, most secure (or at least most dispensable) sources possible. Seeds from properly identified and documented cultivated specimens generally are acceptable for developing propagation protocols.

Recommendation: For developing germination and propagation protocols, or to determine seed storage behavior, use existing ex situ material if available. For extremely rare taxa, it may be advisable to begin with pilot studies using closely related but more common congeners. If wild populations must be sampled, begin with small collections from the largest and most secure. Actual sample sizes should be determined in consultation with those who will be working with or who are familiar with the material in question.

PURPOSE: EX SITU STORAGE

The collection and maintenance of large, genetically representative samples can serve as a hedge against catastrophic loss in wild populations and can provide material for reintroduction and other conservation efforts. Such col-

lections should be made without unduly compromising sampled populations, and this is clearly easiest, most economical, and most effective to accomplish for taxa with long-lived, orthodox seeds. The numbers and genetic diversity of such collections are strongly influenced by the number and size of extant populations from which to collect. And again, the numbers needed for storage depend greatly on what purposes the stored seeds are intended to serve. Should an off-site collection be expected to support a single reintroduction attempt? Two? Ten? Are there other purposes, such as unanticipated scientific research efforts, that an off-site collection might be expected to support?

Relative to stored seed, the cost to maintain off-site samples as actively growing plants is much greater, and the probability of successfully perpetuating the genetic integrity of stored material is much less (Appendix 3, this volume). Presumably somewhere in between are *ex situ* samples maintained as slow-growing tissue culture or somatic tissue stored cryogenically. The genetic integrity of stored seed or other frozen samples also is much more easily and effectively maintained than it is for population samples maintained as actively growing plants. This is thought to be true for several reasons. First, the expected longevity of stored seed generally is much greater than for growing plants. Second, assuming that proper seed storage facilities and techniques are available, both the absolute and relative costs of maintaining the original genetic array of a collection are much less for seeds than for growing plants. Third, it is extremely difficult, if not impossible, to provide habitats off site that are sufficiently similar to those experienced in the wild to avoid artificial selection for unknown properties. Therefore, in addition to the deleterious genetic effects resulting from random genetic drift caused by the small population sizes of a living collection, the genetic adaptedness of growing samples is expected to deteriorate much more quickly in growing collections than in dormant seed collections. Finally, there are phytosanitary and related considerations that apply to growing plants but not stored seed.

Recommendation: Maintain *ex situ* collections as dormant seed, if possible. For seed storage, sample size is limited mostly by available resources, such as the size of the sampling universe, the impact of collection on wild populations, and the technical capability to store seeds for a long period of time. The limit for the number of growing plants is set more by the practical constraints in handling a species than by other factors, so the total number generally is lower for growing plants than for seed storage.

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PURPOSE: REINTRODUCTION, INCLUDING CONSERVATION INTRODUCTION, OR AUGMENTATION

Reintroduction is not a simple one-size-fits-all procedure. For example, experience suggests that the reintroduction of a rare population into a habitat from which it has been extirpated and introduction to a new, apparently suitable but as yet unoccupied habitat hold different ecological considerations, including reasons for extirpation in the former case and reasons for the absence of colonization in the latter case. If biologically and genetically suitable and appropriate propagation material is already stored off site, it should be considered for use before new collections from wild populations are made. Actual sample sizes depend heavily on the management questions being asked of the experiments, and other aspects of the reintroduction plan being considered, such as monitoring and contingency plans.

Recommendation: To develop reintroduction protocols, begin with the smallest collections necessary to address the management questions being posed in the experimental reintroductions.

Sample sizes necessary to support actual reintroductions, enhancements, or augmentations can vary widely. In general, the larger the founding population, the greater will be the chance of it surviving to become an established, self-sustaining population (Guerrant 1996). But it is important to bear in mind that not all reintroduction attempts will succeed, even of species for which propagation protocols have been established empirically. The number of reintroduction attempts that a collection is intended to support and their geographic limitations also greatly affect the sample size needed.

Recommendation: To increase the probability of successfully reintroducing self-sustaining populations of threatened plant species, collect from as large and diverse an array of suitable founders as is prudent, given the sampling universe. Collect and maintain separately seeds from each maternal line. Only in this way can representation of the different founders be known and controlled intentionally.

PURPOSE: OTHER POTENTIAL USES

Sample sizes necessary to satisfy other uses, such as scientific research, education, and interpretation, vary so widely that no general recommendations are possible.

Recommendation: Collection for other purposes should be evaluated in light of their intrinsic estimated conservation value and in light of the cumulative impact of all collection activities anticipated for those species and populations.

Evaluation Cycle

With the choice of taxa made and purposes of a collection articulated, the information can be collated and integrated, and preliminary estimates of sample sizes necessary to serve them can be made (Figure A1.1). Before a final collection strategy can be adopted, initial sample size estimates must be put through two additional filters. The first is the various sources and magnitude of attrition that can reasonably be expected before use. To account for expected losses, sample size estimates must be increased. If appropriate material already exists in ex situ collections, however, the estimated sample sizes may be reduced accordingly. The preliminary revised sample size estimates reflect expected attrition rates and extant ex situ samples. The revised estimate is then put through the last filter, which is an assessment of the probable impact such a collection has on the sampled population. If the expected impact is judged to be too great, then this conclusion is added to the original mix of inputs, some accommodation made, and the cycle repeated. Only when the impact of further collection is judged acceptable should collection proceed.

Sources of Attrition from Collection through Successful Use

It is one thing to collect a genetically representative population sample and quite another to maintain such a collection until it is needed to serve the intended purpose, such as establishing a new, genetically comparable population. There are many steps along the way in which mortality and other losses can occur, in terms of both sheer numbers and genetic diversity. In this section, we consider various sources of attrition, what it takes to monitor them, and how losses can be mitigated. Two major sources of attrition are considered. The first is mortality while in ex situ storage itself, and the other might be considered the demographic cost of reintroduction: the residual fraction of propagules planted that survive and reproduce successfully (Chapter 17, this volume).

Monitoring Survival Rates of Stored Seed

Although estimates of longevity for dormant seed maintained properly are very encouraging—perhaps on the order of decades to centuries for many

orthodox seeded species—some mortality is to be expected. Unlike growing plants, a dead seed generally appears indistinguishable from a live one. In addition to destructive tests such as cut tests or tetrazolium staining tests, it is generally necessary to attempt to germinate subsamples of a collection to ascertain its viability or at least germinability (Chapter 17, this volume). Unless large sample sizes are available (which is typically not the case, especially if seeds from each maternal parent are maintained separately), monitoring viability with a high degree of precision is not likely to be possible. As far as we know, neither this dismal statistical fact nor its implications have been fully assimilated by the ex situ community.

Recommendation: If a species of conservation concern exists in ex situ collections, the survivorship, health, and genetic status of the off-site collections should be monitored. To minimize genetic changes in ex situ conditions, emphasis should be placed on improving storage or cultural conditions rather than or at least before additional wild collection.

Demographic Cost of Reintroduction

Population size targets, often specified as numbers of reproductively mature plants, are commonly indicated in reintroduction plans for specific projects. It is not reasonable to expect that all propagules planted will survive to reproduce, but what is a reasonable expectation? To estimate the range of post-planting decline in population size that might be expected during reintroduction, Guerrant and Fiedler (Chapter 17, this volume) used empirically derived stage-based transition matrices for a variety of plants with life histories as a basis for stochastic modeling.

Not surprisingly, they found that the demographic cost during reintroduction can be substantial. In the most extreme case, an outplanting of 1,000 *Panax* (Araliaceae) seedlings would, on average, be expected drop to just 15 individuals within 3 years before the simulated populations began to rise. Of course, many simulated runs ended with extirpation before any increase could begin. If the newly established populations are to have anything like the genetic diversity of the ones from which the founders were collected, expected losses during reintroduction must be accounted for in the original collection.

These data are simulated results based on wild populations with positive growth rates. One assumption of these models is that outplanted individuals will behave demographically identically to naturally occurring plants, which

is probably optimistic. Another assumption of the models is that the series of years for which data were gathered in the field accurately reflect what will happen during a reintroduction. Presumably there will be many stochastic environmental effects that cannot be anticipated but will affect establishment. In a series of experiments using similar techniques and comparable seed supplies, 27 field germination and seedling establishment trials of *Erythronium elegans* (Liliaceae) set out with fresh seed each year over a 5-year period spanned the range from 0 to 94 percent establishment (Guerrant 1999; Chapter 17, this volume). Clearly, attrition can be high and vary greatly between years.

The implications for any collection effort to support even one reintroduction attempt are daunting. Expected losses of such magnitudes as observed in the stochastic modeling for *Panax* and *Erythronium* suggest that sample sizes might need to be one or more orders of magnitude greater than current guidelines suggest. Unfortunately, such collections may be too large for sampled populations to bear, prohibitively expensive in time and other resources needed to collect, store, and monitor, or simply not possible given the size of the extant population. In addition to increased sample sizes, other ways to compensate for potential losses associated with reintroduction must be explored. One potentially useful alternative is to use physically larger founding individuals, which might be expected to have greater survivorship than physically smaller founders. Of course, there are practical limits to using larger individuals as founders. Likewise, any postplanting care that can be provided to increase survivorship of the founding individuals should reduce sample size needs and predicted losses to attrition.

Recommendation: To compensate for propagule mortality during reintroduction, start with an estimate of desired numbers of individuals surviving to reproduction in a new founding population. Then, account for expected losses during establishment. Some of these calculated losses can be mitigated by maintaining backup clonal material.

Effect of Collection on Extinction Risk

The final question posed by the CPC genetic sampling guidelines concerns the level of collection that necessitates a multiyear collection strategy. Menges et al. (Chapter 15, this volume) used computer simulation to study the expected impact of collection on extinction risk for plants with a variety of life histories. Using empirical data as a basis for stochastic modeling, they

looked at the impact on populations of different sizes (10, 50, 100, and 500 plants) with varying levels of intensity (10, 50, and 100 percent of seed production) and frequency of collection (10, 50, and 90 percent of years). They found that species differed in sensitivity to seed harvest, with long-lived species, especially woody plants, least sensitive. Populations of 500 or more generally were not harmed except by complete harvests for half or more of all years. Small populations of 10 were harmed by less complete harvesting, but sensitivity varied widely by species. Menges et al. (this volume) offered three seed harvest rules:

- Harvesting 10 percent of seeds in 10 percent of years (or less) is generally safe.
- Harvesting 50 percent of seeds in 50 percent of years (or more) is generally unsafe.
- Less intense, frequent harvests are safer than more intense, infrequent harvests.

The first two essentially set quantitative brackets around the third, which is the qualitative heart of the recommendation. Truly safe levels and frequency of harvest depend very much on the population dynamics of a particular population at a particular time and place. We are not suggesting that a level of 10 percent of seeds in 10 percent of years should be considered a standard. Rather, this represents a generally safe level and frequency in extreme situations, understanding that other factors elevating concern over total loss of fragile populations may override the general dictum to "Do no harm."

Recommendation: Less intense, frequent harvests are expected to have lower impact on sampled populations than more intense, infrequent harvests. To the degree possible, spread collection over 2 or more years, especially for small populations.

Extreme Situations

As discussed at the beginning of these guidelines, it is wise not to collect material in volume before methods are available to use it judiciously, given the potential negative impact of collection on sampled populations. In practice, however, there are taxa and situations for which the threat of extirpation in the wild is so high that more extreme measures might be justified, situations in which it might be necessary to act sooner rather than later.

Menges et al. (Chapter 15, this volume) modeled populations no smaller than 10 individuals. Part of their reasoning was the belief that populations this small and especially smaller are inherently threatened with extinction simply by chance. They noted that declining populations represent special cases in which considerations other than the harm done by collection itself might become important. For example, if a population is in decline and sliding toward extirpation anyway, collection affects only the timing, not the end result. In such cases, the potential benefits of collection must be weighed against the additional pressure of collection on extinction risk. Another area not covered directly in the models concerns very small and other populations for which the probability of extirpation in the foreseeable future is so high that rescue collections might be of conservation value and therefore worth the additional risk. The question then arises of what to do with very small populations that might be particularly susceptible to extirpation in the near to medium term (5–25 years).

Although it is always best to keep in mind the dictum “Do no harm,” it may be necessary in some situations to collect so much material that collection itself becomes a serious threat to the sampled wild population, at least in the short term. There are cases in which future prospects are so bleak and successful reproduction so unlikely to happen in the wild that it may be prudent to harvest many if not all propagules for conservation use. The efforts to recover the California condor (*Gymnogyps californianus*) and the black-footed ferret (*Mustela nigripes*) are two cases in point. When only a handful of individuals were believed to exist in the wild and even fewer in captivity, emergency efforts were made to capture all remaining individuals, thus driving the species to extinction in the wild, at least temporarily. In both cases, these animals were used in captive breeding programs whose primary goals are to release many more individuals into the wild than were removed, in more areas than just the original collection sites. Thus, we may ourselves be in the uncomfortable position of destroying a wild population in order to save it.

Recommendation: For populations of species with extremely low over-all numbers, particularly those that have 10 or fewer reproductive individuals and a poor history of recruitment or those that are known to be in precipitous decline, collect up to 100 percent of seed at the discretion of the permitted collector. Such collection levels assume that adequate facilities, procedures, and resources are available to care for the material and that such collections are part of a more inclusive strategy that is endorsed by the appropriate regulatory authorities.

Worksheets

A series of worksheets are provided to assist practitioners in estimating appropriate sample sizes (Figures A1.2–A1.4). Figure A1.2 can be used to summarize the status of a taxon in terms of how many populations of what size are known and of its biology and provides space to organize an initial needs assessment of what sample sizes are needed to supply anticipated purposes. The second and third worksheets bring the analysis to the population level. Figure A1.3 provides space to evaluate five populations for how many propagules each might supply to serve various networks. For taxa with more than five populations, multiple copies of this worksheet may be needed. The final worksheet (Figure A1.4) allows initial sample size estimates to be viewed in the context of existing collections and for final target collection sizes to be set. It may be necessary to cycle through the latter two worksheets several times during the evaluation process before a final target is decided.

Conclusions

The basic structure of the collection guidelines offered in the original CPC guidelines is sound. However, this appendix recommends that the actual number of propagules should be revised upward, perhaps by one or more orders of magnitude in some instances. In the most recent and thorough statistical treatment of sampling strategy of which we are aware, Brown and Marshall (1995) have a benchmark target of 50 individuals per population in each of 50 populations per ecogeographic region per taxon. We endorse this strategy as a first approximation against which actual sample sizes are determined.

All numbers are subject to change, and any collection strategy must be tempered with consideration for the purpose of collection, ability to maintain the samples in good condition off site, and damage to wild populations done by collecting itself. After all, off-site samples are part of a larger integrated conservation program, the ultimate purpose of which is to increase the long-term survival prospects of sampled populations in the wild.

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Taxon _____

Population number and sizes _____

Seed storage behavior: Orthodox, Intermediate, Recalcitrant, UnknownLife history: Annual, Short-lived perennial, Long-lived perennial, Woody, Herbaceous, ClonalBreeding system: Selfer, Outcrosser, Mixed mating system, UnknownReproductive output: Seeds per fruit (one, few, many, or mean number if known)

Fruits produced per plant per year _____

Germination fraction _____

Knowledge status: _____

Germination _____ Propagation (standard horticulture) _____

Propagation (in vitro) _____ Seed storage behavior _____

Indicate sample sizes and source populations for each purpose and for each time period.

Purpose of Collection	Near-Term Needs (1-3 years)	Medium-Term Needs (3-7 years)	Eventual Needs (7+ years)
To develop protocols			
Germination			
Propagation (standard horticulture)			
Propagation (in vitro)			
Seed storage behavior			
Ex situ storage			
Orthodox seed			
Attrition (rate)			
Recalcitrant seed			
Attrition (rate)			
Cryopreservation of tissue samples			
In vitro slow growth			
Attrition (rate)			
In cultivation			
Attrition (rate)			
Reintroduction			
Attrition rate (including demographic cost)			
Augmentation			
Attrition rate (including demographic cost)			
Other			

FIGURE A1.2 Genetic Sampling Guidelines Worksheet: Preliminary need assessment worksheet on which to summarize biological status and knowledge of a taxon and organize initial estimates of what sample sizes might be necessary to serve various potential needs for ex situ material. (For a printable version go to <http://www.islandpress.org/conservation/conservation.html>.)

Appendix C
Planning to Build a Native Plant Nursery
(Young, B. [no date])

Planning and Building a Container Plant Nursery

Chapter Contents

- I. Do We Need a Nursery
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- III. Shadehouse
 - a. Anticipated capacity
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 - a. Anticipated capacity needs
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- IX. Compost area
- X. Native habitat garden demonstration area
- XI. Handicapped accessibility
- XII. Rough cost estimates

DO WE NEED A NURSERY?

Do you need to build or rebuild our nurseries? Or if you are part of a community based restoration program (not part of the GGNRA, do you need a nursery at all? That question has been answered here in the GGNRA. The answer was yes, 5 of them in fact. But for those of you who may be considering building your own. If you have no ethical and reliable local nursery that grows natives for restoration on contract, then you have little choice but to build your own.

If you do have a good commercial nursery in the area, then there are several considerations.

- Financial – even the smallest nursery needs at least a part time employee to provide reliable service and an accumulation of knowledge about your plants, as well as how and where to collect the propagules and grow each species. This is your largest ongoing expense. Aside from the initial capital costs of building, **salary, taxes, and benefits for the manager are the main expense**. Volunteers are wonderful and essential to most operations, but very seldom do you have a volunteer who can dedicate the time every day to successfully grow the plants needed. Would these costs of staff be less than the average amount of your yearly nursery contracts currently? There are other costs of course, such as vehicle expenses, rent or mortgage, utilities, insurance, computer set-up, supplies for growing, tools, safety gear, and facility and equipment maintenance.
- Community support – sometimes it is worth the capital and ongoing staff cost for a nursery, even though not a financial savings, because it provides an anchor and incentive for community participation. A nursery can provide a place to base your nursery and field programs and provide an opportunity for what are currently field volunteers to help grow the babies they will plant. A welcome relief, if they have been only doing weed control for weeks on end. Furthermore, growing plants is constructive not destructive. The nursery is a wonderful opportunity to build a volunteer and advocate base for your organization.

Nuts and bolts of dollar crunching are at the end of the chapter.

In native plant production for habitat revegetation, methods of growing are very different from bedding plant or “normal” landscape plant production. These differences will be discussed in more detail in the chapter titled “How Plants are Grown Differently for Restoration.” Some of the pertinent differences are:

- Only one delivery time per year. Crops are delivered in the winter for planting during the rainy season. The fact that we only grow one cycle of crops per year determines the size the nursery needs to be.
- Seed and other propagation material should be collected from as near to the restoration site as possible. There is a compelling body of research to support this practice.
- Seed pre-germination treatments and propagation are timed for delivery in the winter. Woody plants are propagated from the previous winter through spring, herbaceous from late spring through summer.
- Most crops are grown in the nursery for only one year. Exceptions are ferns from spore and bulb plants from seed. These require 2 years in the nursery.
- Plants are grown in long straight low soil volume tubes. These promote a good root system and proper root to shoot ratio and are space efficient. However, watering at more frequent intervals, shading, and elevated growing surfaces are recommended. It is also efficient to consider the container and rack sizes when designing nursery benches and structure layout.
- Fertilizer use is lower than the amounts used in other types of growing.

- Propagation is 98% from seed, to promote genetic diversity. A seed cleaning lab and organization area is needed.
- Many small crops rather than few large crops are grown. Container benches or beds are not large, irrigation stations are smaller than commercial nurseries to accommodate the various irrigation needs of plants from different habitats and in different size containers.

If you decide that building a nursery for your organization is necessary, the following are considerations for site and design needs.

SITE CONSIDERATIONS

Consideration of any site for possible use as a nursery requires evaluation of many factors; location in relation to projects and neighbors, water quality and quantity, utilities, drainage, roads, space for structures-greenhouse, shadehouse, potting shed/office, seed cleaning and storage, material and tool storage.

We will consider existing features, water, utilities, roads and then discuss structures combining all these factors into the total area of land needed for a nursery. A nursery will change and possibly degrade the ecological quality to the site upon which it is build. Hopefully, the nursery will be managed in a manner to avoid degradation but it should be analyzed to determine if there is a net gain in environmental quality by having a nursery that produces plants for habitat restoration.

Location

Seed collection is much easier and more time efficient if the nursery is close to the area from which seed will be collected. This is mandatory if the nursery does not have access to a vehicle.

Consideration of neighbors is important. Having neighbors close by will provide possible volunteers for the nursery, if it is a community based organization. On the other hand close neighbors may have concerns about additional traffic, pesticides, fertilizers, water runoff, and dust. All of these concerns should be addressed in your planning and permitting activities.

Water quality and pressure

Plants growing in containers have limited soil volume from which to absorb water. Therefore, even native plants must be artificially irrigated. Water, if from a municipal source should be of adequate quality. However, it is a good idea to check for salts, Electrical Conductivity (EC-milliSiemens/cm) should be less than 2 and ideally 0.25-0.75. Sodium Absorption Ratio (SAR) less than 10. pH neutral to slightly acid 6.2-7, Water pressure to the site should be at least 50psi, if water must travel any distance to the shadehouse. To use automatic sprayers for irrigation, a psi of 35 is minimum. Typical municipal water supplies run at 60-75 psi.

Utilities

- Water - a water line adequate for the irrigation required must be brought in. For 100,000 plants or less, usually a 1 ½ -2" mainline is adequate.
- Electricity - 110 volt line will be needed for the office/propagation building and for environmental controllers. If a boiler is used for bench heating in the greenhouse, a 220 volt line, natural gas or liquid propane (LP) will probably be needed to the boiler. A walk-in cooler for seed storage will require 220. Greenhouses for native plants

production do not need to have the air heated or be air conditioned in California. Even evaporative cooling is usually not necessary along the coast. If daytime temperature exceed 85°F then evaporative cooling for the greenhouse should be considered. However, this requires only 110 volt line of electricity and water.

- Natural or propane gas is not needed for the greenhouse but may be needed for hot water tanks in kitchen/break/bathroom and to heat the classroom/propagation /office area. If controllers are housed in the headhouse a 110 line can be housed there. If there are automatic systems, vent motors, shade openers, fans or an evaporative cooling water pump in the greenhouse, a 110 line will be needed to the greenhouse.

Drainage

This site must be well drained. Standing water is an invitation to pathogens and worker injuries in the nursery. A nursery site should never have standing water, even in winter. If this is a problem french drains can be installed, however, this is very disruptive to the on-site soil structure. French drains require a 2- 4% slope. If the area is flat, and therefore not conducive to a drain system, rock can be laid down to bring the platform at least 4 inches above areas of standing water. If the native soil infiltration rate is low, then rock or gravel should be considered in growing areas to keep workers and plants from standing in water.

Grading and water containment

The greenhouse, shadehouse and outside growing areas should be graded to promote drainage of water away from the growing area. In some counties, water containment on site is required of a nursery. This is typically done though french drains that channel all water to the low spot on the site. It is then pumped to a containment pond, checked for nutrient levels, filtered and reused. An option on this site may be the channeling of any runoff to a constructed willow and wetland area. This method has been used with success at some nurseries and water treatment plants to purify water before it is allowed to drain into a storm drain, creek or ocean. This would require the ability to test inlet nitrate levels and outlet from the wetland to prove water has been purified. Here we use constructed wetland on the downslope of each shadehouse. If capillary mats are used for irrigation, normally a 2% grade is required so that they drain properly.

On the Presidio, compost tea is made for a local golfcourse, playing fields and for nursery use. Compost tea is made from unchlorinated water, therefore a water catchment system from the roof would be a great asset for collecting water to make tea during rainy months. The challenge of water catchment in California is collection of enough water in the winter and storing it through summer. Just for compost tea, 15,000 gallon of water is used each year, that's 270- 55 gallon drums, or a very big tank. This is magnified if all irrigation water is to be retained on the nursery site. This is ideal, environmentally, but very expensive. Minimum cost for equipment and grading is around \$50,000.

Truck access

To have a nursery "out in the wild" is a lovely idea that will not work. Aside from the fact that a nursery will severely alter the environmental quality at the site, every nursery requires deliveries on pallets of containers, perlite, vermiculite (if used), propagation media, and container media. This requires a roadbed that is useable by a dump truck and truck and trailer rig. Compost must be moved to a mixing area or moved off site, which can be achieved using a pickup truck or tractor. Additionally, plants must be loaded from the shadehouse or outside growing area to trucks for delivery to the

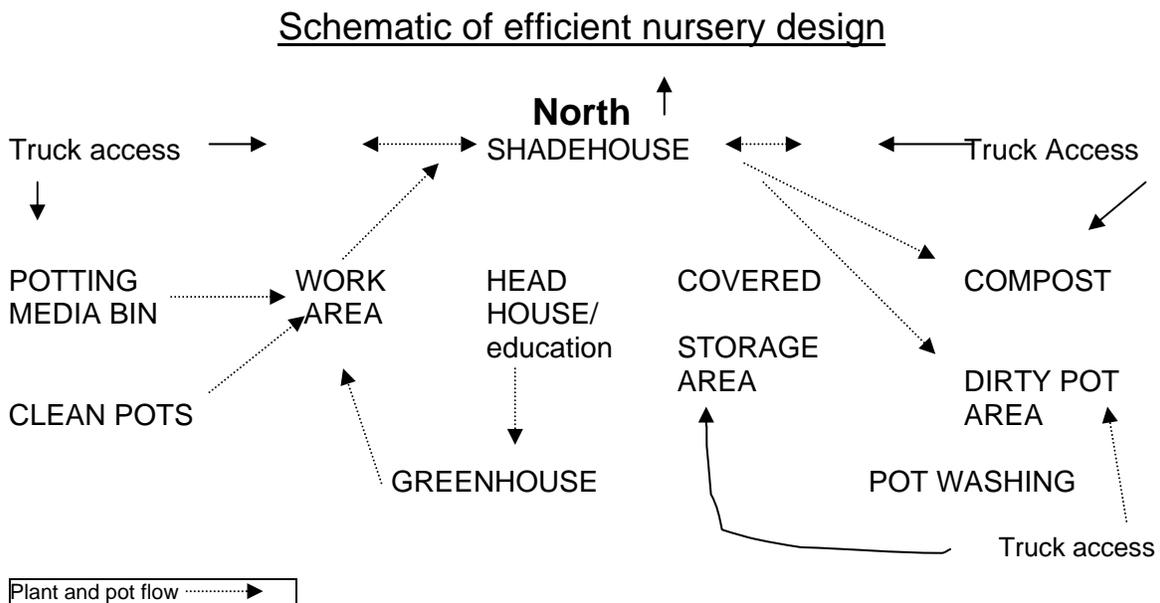
outplanting site, which may also be done using a flatbed, pickup or truck and trailer. Place nursery structures to allow truck access to bring in purchased containers and supplies, to bring back used containers, and to the shadehouse to pick up plants for planting. Room for truck turnaround should be provided to allow sufficient room for a truck and trailer. Most trucks are set up to be unloaded with a forklift. Since most of us do not have one, people will be required to unload each delivery. It takes a tremendous amount of heavy lifting and time if loads need to be carried long distances by hand or on nursery carts. Because of these requirements, roads within the nursery typically require 60% additional area, which adds an additional large area to the space needed for you site.

STRUCTURAL DESIGN

Direction

Greenhouses are most efficient if the long side faces south. This promotes maximum hours of sunlight for plant growth. The headhouse should be to the north or east of the greenhouse with access from the headhouse directly into the greenhouse. Seeds should be sown on flats in the headhouse out of direct light and wind. In an ideal world, there should be a door that opens from the headhouse into the greenhouse so that seeds are not blown off flats on their way to the greenhouse.

To maximize efficiency, facilities should be placed schematically in a circle or open rectangle. There should be an easy flow from one area to the next. Growing begins with clean pots, which receive potting media from a storage bin, the pots then go to the work area for transplanting, or for direct seeding. They then go into the shadehouse, and from the shadehouse to the field. Dirty pots come back from the field, are washed and begin the cycle again.



Parking

Don't forget parking for volunteers. Consideration should be made for school buses if there will be educational programs. Electric plug-ins may also be needed for electric vehicles.

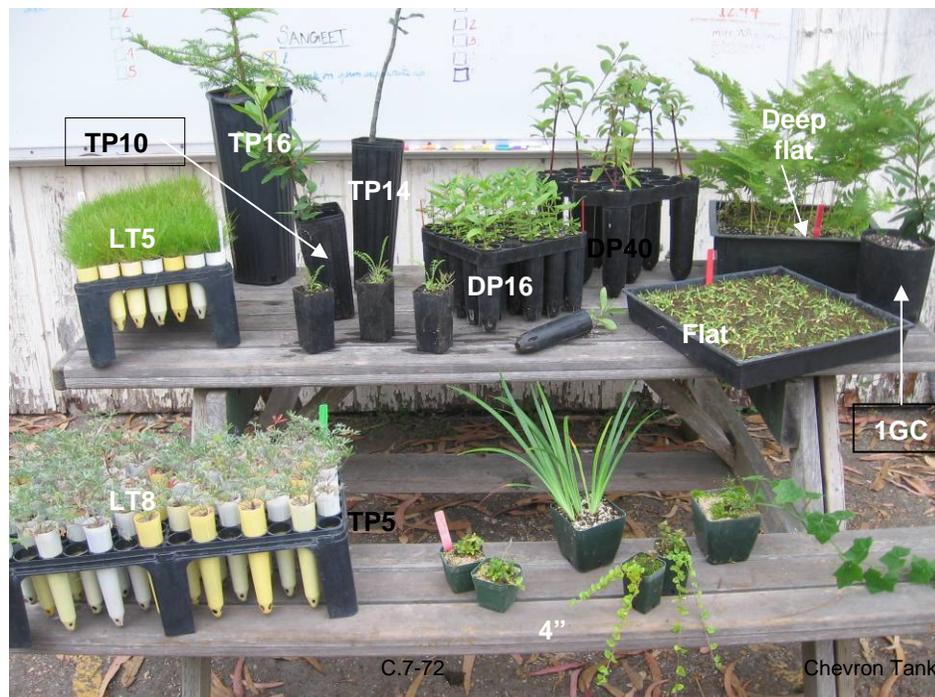
SPACE REQUIRED**Shadehouse**

Due to the use of low soil volume containers, growing under shade is usually required. Even with the coastal fog and cooler temperatures in the San Francisco Bay area, containers with as little as 8 cubic inches of media will quickly dry out if not under shade. Because plants take up much more space in their final pots than as seedlings in the greenhouse, the shadehouse size is the most critical calculation for a nursery. The greenhouse size is secondary.

Benches or Growing beds in Shadehouse

In native habitat revegetation production, there is typically only one delivery time per year - the winter. Normally, only one crop per year can be grown. This compared to the turnover in a bedding plant production facility every 10 weeks during the gardening season. Therefore, there must be space in the nursery for all of the plants for a season. Native plants to be grown for habitat revegetation are typically grown in differing size tubes. The tubes noted below have internal ridges forcing roots to grow straight down through the pot and large drainage holes promoting root pruning as roots reach the bottom of the pot. This prevents circling roots. They are also very space efficient (up to 49/ft² compared to 1 gallon cans at 3/ft²). If there is a request for larger plants (1 or 5 gallon) space needed for growing increases dramatically. One full 5 gallon container will require 4-9 ft².

Envision what your maximum production level will be, then the container size in which they will be grown. Now is the time to learn MSEXcel, if you don't know it. Calculate the total bench area needed based on the information below. This determines the space needed for plants, whether on the ground or on benches. For sanitation and insect and disease prevention, benches work best. Taking the bench area plus aisles determines



<u>Container Type</u>	<u># per sq ft</u>	<u>Number per rack or 16"x16" flat</u>
Leach tube 5" (1"x5")	49	98 (per rack - 1'x2')
Leach tube 8" (1"x8")	49	98 (per rack - 1'x2')
2" standard nursery pot (2"x2"x3")	36	64 (per flat 16"x16")
4: standard nursery pot (4"x4"x4")	9	16 (per flat 16"x16")
1 gallon can (6"x6")	3	Stand alone
5 gallon can	1	Stand alone
Deepot 16 (2"x7", 16 cu in)	25	25 (per rack - 1'x1')
Deepot 40 (2.5"x10", 40 cu in)	20	20 (per rack - 1'x1')
Treepot 5 (2"x2"x5" open sleeve)	36	64 (per flat 16"x16")
Treepot 10 (4"x4"x10")	9	9 (per milk crate-1'x1')
Treepot 14 (4"x4"x14")	9	9 (per milk crate-1'x1')
Treepot 16 (6"x6"x16")	4	4 (per milk crate-1'x1')
Treepot 18 (8"x18")	1	Stand alone

When growing a fairly **complete** plant palette (meaning grasses, perennials, shrubs and trees) for a habitat revegetation, the sizes tend to average out with many grasses grown at 49 per square foot and a much smaller percentage of woody shrubs and trees at 20 or 9 per ft². This square footage is actual bench or on the ground growing area and does not include aisle, work or storage space in the growing area.

In the GGNRA nurseries, our most commonly used pot size is the Deepot16, since we grow mostly herbaceous perennials. Using that as an average to guess at size needed, usually works fairly well, if your operation would be similar. Take the number of plants you expect to produce, divide by 25. This is the square footage needed if all plants are in Deepot16s and jammed pot to pot. Add 30% to this square footage to avoid crowding. This is the amount of bench space or actual growing space needed.

e.g. 10,000 plants in Deepot16. $10,000/25 = 400$ sq ft of plants.
 400 sq ft + (30% of 400 sq ft) = 520 sq ft of total bench space in shadehouse.

At least double that for aisles (1.5 minimum and 3 times is even better to avoid injuries to workers) to get the size shadehouse needed. Nursery carts with a deck of 2'2" work well for these containers, so one 2' wide rack or two 1' wide racks fit easily. To go one way, at least 3' wide aisles are minimum, 4' aisles make working much easier. For two way traffic, 6' works well. For a rough estimate of the shadehouse size needed, multiply the total bench area times 2 to 4, depending on the bench layout and aisle width. In the example above shadehouse total area would be 1,000-2,000 ft².

Bench space in the greenhouse for a revegetation nursery is usually about ¼-1/10 the amount needed for the shadehouse, depending on timing of seed sowing and cuttings. If all propagation is done at the same time, a larger greenhouse will be needed. If propagation is spread out over many months, a smaller greenhouse will suffice. Size also depends on bench layout and aisle width, which will be discussed later. But typically 2-3 times the total bench area will give you a rough estimate of size of shadehouse needed. Based on either 60,000 plants delivered (70,000 - 80,000 propagated) or 10,000 plants per year, an estimate of the needs follows:

Structure -see spreadsheet for current sizes - needed space shown below	<u>Square feet</u> 80,000 plants	<u>Square feet</u> 10,000 plants
1. Area under shade cover.	9,000-11,000	2,000-4000
2. Bench space within shadehouse.	4,200	520
3. Greenhouse -total size of structures- of that 500ft ² of bench space under mist	2,500	216 ft ² , 12x18'
4. Bench space in above greenhouses.	960	72-108
5. Headhouse - Propagation, seed storage and seed lab w/ walkin cooler (motor soundproofed)	2,000 3,000 feet if education programs	At least a countertop and sink with cabinets
6. Covered storage	2,000	150
7. Dirty pot storage area	500	20
8. Composting area	600	20
9. Covered Container media storage area	100	20
10. Outdoor work area - covered Not needed if adequate room inside	1000	150
11. Truck access 18' wide graveled roads to storage area, compost area, and shadehouse. Include a truck turn-around area.		

OTHER CONSIDERATIONS IN NURSERY DESIGN

Worker safety, convenience and efficiency

Benches should be used for growing of plants once they are in their final containers. This not only provides good cultural control of insects and diseases but prevents back injuries to workers and volunteers and promotes root pruning in the containers. The height of benches should be about 8" lower than the typical height of a worker's elbow. This allows for the height of the tubes above the bench. Once plants are placed in the shadehouse, the working surface is the top of the plant container, not the surface of the bench. The top of the pots is then in front of the worker and allows the worker to function with arms bent at right angles. Bench height is typically about 32", assuming female workers. If benches are too low, workers are bending over and back injuries can occur.

The benches in the greenhouse should be no more than 3' wide (2' even better) if there is access to only one side or 6' wide (4' better) if there is access to both sides. 4 ft wide benches in the shadehouse are much easier on back. It is almost impossible to groom plants in the middle of a 6' wide bench without using a step stool or taking the plants off the bench. Using 4' wide benches is worth the cost compared to a single back injury. This allows workers to water, groom and weed plants without bending forward or reaching up and over.

Plant delivery and pickup

If the area is not accessible to deer, then shadecloth need only be applied to the top, west and south sides. If completely enclosing the growing area, to exclude predators, rodents, etc, then access should be provided to the shadehouse from both ends and from the side facing the potting area. The ends facing the access road should have at least 8' wide doors.

Aisles between benches should be at least 4' wide, so a nursery cart can be wheeled into the house for plant delivery and pickup. 6 - 8' wide aisles allow to carts to pass each other. 10' wide aisles allow a small pickup truck to drive into the house. Of course, as access area is increased, plant production area is decreased.

TYPES OF SHADEHOUSES

Any material for a shadehouse or greenhouse will have an environmental cost. Consideration should be given to the least toxic most renewable product. Kits are available made usually from galvanized steel posts, shadecloth and cabling for structural support. A kit for a 1600ft² shadehouse will cost from \$1800-3000 (2007 \$) without installation.

If wood is available for free, a shadehouse can be constructed fairly easily. Redwood or pressure treated fir will last longest of the wood products; unfortunately, both have environmental consequences. However, any other type of wood will quickly rot. Many counties have recycling facilities with used wood available. Newer types of pressure treating are less toxic (arsenic is the problem in older methods) but still contain heavy metals. If used, be sure pier blocks or concrete footings are used to prevent wood/soil contact. Be sure any cross bracing is above head level. If wood must be purchased, a manufactured kit will probably be less expensive. Professional installation will probably double to triple the cost. Add to that, grading, and gravel. Many counties now also produce recycled drain rock from concrete. If you know the source of the concrete is clean, this is a wonderful option. Usually, the facility cannot tell you from what type of concrete the rock was made from, so you are not sure what it might contain that would leach into the soil. Currently, it is not easy being green. Hopefully, this situation will improve so that content and origin information is readily available. Here, we chose to rebuild rotted wood shadehouses with galvanized steel, for least metal leaching, permanence of material and ease of construction.

Shadehouse covering

Either white or black shadecloth can be used. I would recommend a 30% light reduction shadecloth on the coast and 40% weave if inland for most natives. Shadecloth comes in widths from 10-30 ft and can be purchased with or without grommets. Having grommets added significantly increases the cost of the cloth. An alternative to grommets is the use of lockties to attach shadecloth to cabling. Ideally, having a system that allows the shadecloth to be pulled back in an area of the shadehouse, allows for maximum flexibility of growing conditions. Shade can be removed from areas housing sun-loving plants and in the late season hardening off period. There are automatic shade systems that will pull shadecloth depending on wind velocity and light levels.

Floor Coverings

Weed prevention is extremely important in the shadehouse and greenhouse. Weeds in the shadehouse can promote weed growth in containers, insect infestation, and fungal

and disease problems. If water containment is not an issue, there is no standing water on the site, and the ground is smoothly graded, 100% weave black landscape fabric can be used to cover the ground for weed control. This allows for water infiltration to the ground, which promotes continuation of microbial processes in the soil. Soil microbiology under the shadehouse will be altered also simply due to the lack of vegetation. If ground is uneven, there is standing water, and again water containment is not required, gravel (3/4 drain rock) can be used to level out the site and raise growing area above standing water. If water containment is included or if French drains are needed to drain standing water; drains will need to be installed before final grading, as do main irrigation lines.

IRRIGATION

Automatic irrigation is not mandatory. However, particularly if the nursery is reliant on volunteer maintenance, automatic irrigation at least guarantees plants will be watered (unless there is a power failure) whether or not the waterer shows up that day. Even if there is a nursery staff, this prevents workers coming in on their days off to irrigate and saves thousands of hours of labor each year.

There are many irrigation systems available. The drawback of any round pot is the empty space between pots. This space is watered along with the plants and water is wasted. However, drip irrigation using spaghetti tubes is not feasible with the small diameter growing tubes. Imagine 49 drip emitters and spaghetti in each square foot of bench. Drip irrigation with spray emitters can be used if water pressure at the main head is less than 50psi. However, if at the automatic valve water pressure is less than 20psi, drip emitters will not give complete coverage. Sagging of drip lines can cause uneven flow from emitters.

I would recommend, overhead sprinkling with shrubhead type emitters. If you are watering a large area (20'x20') with a single crop, irrigation can be from a single impulse sprayer. However, usually the native plant nursery is growing many small crops, each having different requirements. I recommend many stations or automatic valves, providing maximum flexibility in irrigation frequency and duration for different species and container sizes. This promotes water conservation by the precise setting of irrigation times.

The drawback of 4' wide benches is that there few emitters with a 4' radius or 2' radius if full circle emitters are used (2007 information). There currently is only one brand (Hunter) of full circle emitter that will cover that short a radius. Fortunately, after testing all available shrub-head type emitters, this brand is also the most uniform in coverage. This allows watering times to be set to the minimum needed to water all containers of the same depth uniformly. We install them along the edge of the bench using half circle (180°) and quarter circle (90°)

GREENHOUSE

Capacity needs

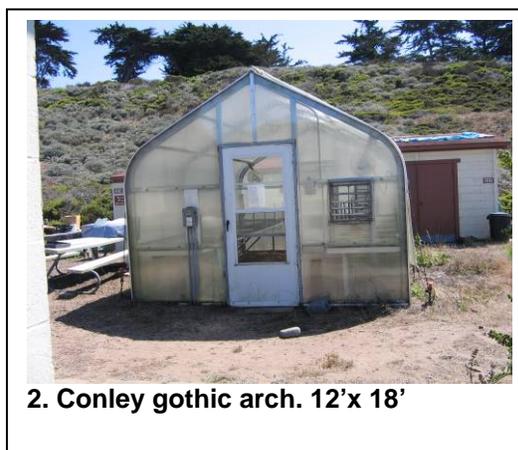
As discussed briefly above, in the greenhouse most propagation for herbaceous plants is in 16" square flats, 2" deep. An average of 200 seedlings per flat can be used for space needs calculation. These seedlings are typically transplanted into deepot16, taken to the shadehouse and placed on benches at 25 per ft² plus 1/3 additional area for spacing racks of plants to promote air circulation. Therefore, the 200 plants in 2.25 ft² of

greenhouse space, in this case, take up approximately 11 ft² in the shadehouse, a factor of 1:5 space in greenhouse compared to the shadehouse.

Additional space is needed for crops sown directly in tubes that require greenhouse conditions for germination. Benches usually occupy about 1/3 of the total greenhouse area. However, plants are started at varying times throughout the season. Shrubs and trees are usually direct seeded in the final tube, to prevent kinked roots. This is in late winter-early spring after pre-germination treatments.



1. AgriTech Square truss. 30'x50'



2. Conley gothic arch. 12'x 18'

Types

I strongly recommend the use of a commercial quality greenhouse. Homeowner type kits are simply not constructed from materials that will withstand constant use, irrigation, and weather changes. Common types of houses are quonset, gothic arch or square truss roof shapes.

Manufacturers

The major commercial manufacturers in California are McConkey, AgriTech and Conley. I have used both AgriTech and Conley with good results. Customer service has been better from AgriTech. We have used 20x50 and 30x70 Square truss AgriTech houses and 10x12 and 12x18 Gothic arch Conley houses. Poly-Tex is a manufacturer in Minnesota that is also high quality and responsive; however, shipping costs must also weigh into your decision. Poly-Tex specializes in air-filled collapsible tube vents and double walled air-filled glazing. It is a heat conserving method and the poly covering is much less expensive. However, blower fans are used to inflate the glazing and the vents. I have had problems with fans due to the humidity in the greenhouse. Also, I found the poly must be replaced approximately every 3 years, this is very labor intensive and the cost of frequent replacement quickly negates the initial savings. Plus, the poly must be disposed of after use.

In Coastal Bay Area, for native plants an evaporative fan and pad system is usually not needed. However, roof and side vents are essential. Temperatures for healthy and active plant growth should not exceed 90°F. Without cooling or proper venting the greenhouse will readily heat beyond this temperature. This allows for passive cooling in the summer simply due to the chimney effect – cool air in the bottom vent on the cool north side of the house and hot air out the top. The higher the roof-vent the more

effective the cooling. In addition, square footage of the roof vent should be about 10% of the area of the footprint. Quonset houses do not perform this venting function and are not recommended, they require fans and evaporative pads to cool. This system is less expensive than air conditioning and very effective in the dry west. However, the passive roof vent system uses no resources other than a motor to open the vents. Vent openers for small greenhouse require no electricity. I recommend straight sided with peaked roof greenhouses (truss roof). All of the above listed companies manufacture this type of house.

Coverings – glazing

The least expensive covering is polyethylene film. It will last 1-5 years depending on quality, thickness and UV inhibitors present. 6 mil thickness should be used. For best results and to maximize energy efficiency, use two 6 mil thick polyethylene covers separated by a small amount of airspace. The covering will also need to be replaced frequently and has to be disposed of in the landfill. Coverings can also be applied to some types of houses in tri layers, making your greenhouse even more energy efficient but also creates more waste. The average cost of polyethylene film covering is about \$0.10-0.25 per sq ft of material. Special brackets must be purchased to attach the material to the greenhouse structure.

Polycarbonate corrugated sheets provide good light transmission and will last up to 20 years. (\$1.50-2.00/sq ft) This material is not as heat efficient as double walled polycarbonate. (Lexan). (\$2.00-2.25/sq ft) This material works like double pane windows for heat retention and will also last 20 years. Condensation between the layers can be a problem, but is usually avoided by proper installation.

Shade material should be used in the summer to cut light transmission. 40-50% shade cloth is typically sufficient.

Rough cost estimate

AgriTech manufacturers greenhouses that are 18' or 30' wide and lengths in increments of 12'. The kit used for a 20'x50' was \$17,000. With benches, irrigation, installation, 110 electrical, sensor, automatic shade and misting, etc. the total construction cost was about \$60,000.

Whereas, the shadehouse can be built fairly easily with non professionals-volunteers, the greenhouse should be built by an experienced contractor or construction experienced maintenance crew. I speak from sad experience, it is more economical in the long run to pay a contractor to do it right the first time. Roughly assume that building costs will be double the cost of the kit.

Equipment

- Vent motors have already been mentioned. 110 volt wiring is needed, unless you use small vents with passive gas filled openers. Roof vents for passive colling should be a minimum of 10% of the square footage of the footprint of the house. (e.g. if the greenhouse footprint is 10x12, 120 sq ft, then the roof vent should be at least 12 sq ft.
- Sensors, in the best of all worlds, are very useful and substantially increase germination percentages. These sense sunlight (luminescence), humidity, temperature, inside and out. They automatically open vents, turn on propagation mist, pull shade fabric and start circulation fans. This system is expensive up front

(typically cost \$3000-5000), but conserves seed and propagule resources. More significantly, sensors will adjust for weather changes when there are no staff present. This prevents crop loss on weekends, particularly when there are significant changes in the weather.

- Automatic mist system, whether controlled by a timer or by sensors is a must. Seeds will dry out and die without surface misting.
- Benches keep containers off of the ground inhibiting the passing of insects and diseases. They also prevent roots from growing into the native soil and promote root pruning at the bottom of the pot. Possibly more important, they protect workers' backs from injury.
- Bench heating. To speed propagation and particularly for species requiring cuttings, heating under the bench is needed. The air in greenhouses in California does not need to be heated.
- Two circulation fans would be needed for a 20'x36' house, to move air in the greenhouse. This inhibits fungal spore germination by promoting leaf surface drying. Fans also mix the air to maintain a constant temperature floor to roof. They should be positioned to create a circular flow around the house.

Benches

Benches, in greenhouse or shadehouse can be constructed from wood or can be as simple as pallets on cinder blocks. Cinder blocks are a good option if benches will be moved and will allow for height adjustments fairly simply. If wood is used, the surface of the bench should be open so pots are not in contact with wood. This will promote root pruning. If cross-members for the bench top are on 1 foot centers, this will hold the legs of racks manufactured for the common tube pots used in revegetation.

Galvanized steel is my favorite type of bench construction material. Expanded galvanized steel or open weave plastic bench tops can be used. Both are easy to clean, will not allow algae buildup, prevent standing water, and the open weave allows good root pruning. For the shadehouse, be sure construction is engineered to take up to the 30 pounds per square foot needed for filled racks of tubes.

Rolling benches are the most space efficient by allowing for only one or two aisle spaces in a greenhouse. The tops of the benches are rolled over the legs to make an aisle where needed. However, I would recommend stationary benches where students or volunteers are working. This way there are aisles around every bench, in which the students and workers can stand. If expanded metal is used, hot water tubes can be installed under the bench, enabling flats and racks of plants to be slid smoothly across the bench.

Heating

Air in the greenhouse does not need to be heated for native plants; however, a bench heating system for propagation in the winter and spring will be useful. The most fuel efficient system is hot water recirculation. Alternatively, electric coils can be used but this type of system is very energy inefficient. With the hot water system, black spaghetti tubes are coiled back and forth on the bench every 2 inches. Heated water circulates from one end of the bench and back to a manifold and is returned to the boiler. Manufacturers are Delta T in Southern California and BioTherm in Petaluma. A system with boiler will cost around \$2000-3000 to heat all benches.

Misting and irrigation

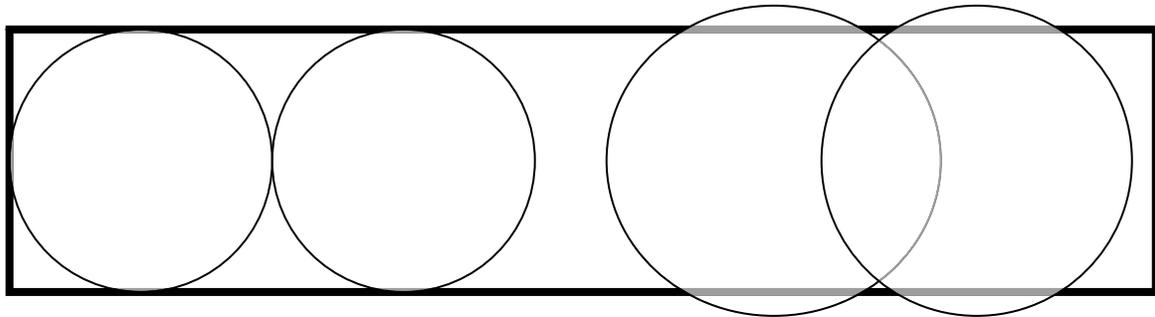
A mist system is essential if there is a time when workers are not close by to supply mist



by hand to germinating seeds and cuttings. There are several types of emitters, all of which will require PVC irrigation pipe. Due to the fine droplet size, these emitters will cover a 3' radius at 35psi. Flora-mist brand are the classic brass emitters. They are installed with T-adapters in the 1/2" irrigation line. They can be subject to clogging. Baumac-brand are brass mist nozzles which will screw into a 1/2" x1/8" tee irrigation fitting. I have not used this brand but have seen them functioning and they appear to be very

uniform. For either 35-40psi water pressure is needed. Emitters are placed 3' apart or closer if benches are 3' wide. Otherwise, there will be v shaped dry spots at the edge of the bench, where the diameters of the spray circles do not meet. If benches are 6' wide then emitters can be in two rows 3' apart.

The pattern below would be for overhead emitters down the center of a bench. Emitters are more water efficient if put on the edge of the bench using quarter and half circle emitters but should then be staggered. Then there is no need to water past the edge of the bench.



3. 3' apart emitters

vs.

1.5' apart

Netafim also makes a mist nozzle, the VibraMist, that is designed to be used overhead. We have tried them and a fairly uniform spray is provided, however, watering occurred over a 4-5' diameter, so water is wasted on the aisles. On the other hand, having the mist system hanging out of the way of



2 building a nursery

workers is great and it leaves the bench totally open for flat placement. We have not found the emitters to be very long lasting. Students love to bat them around. Whatever brand is used, good filtration is essential as the orifice of the misters is so small. It is helpful to have the mist system hanging from above and out of workers way. There are other brands and many new types that we have yet to test out. Most would likely work quite well. Fine mist nozzles rather than sprinklers or foggers must be used. Schedule 80 (gray opaque) pipe should be used for above ground pipes in the mist system, otherwise, algae will grow and clog fine orifice emitters.

With only one greenhouse, having both a mist system and sprinkler system on each bench gives maximum flexibility. This can be a single set of irrigation lines and risers (nipples) if automatic controller can be set for irrigation (e.g. 20minutes only every 3rd day) or misting (20 seconds every half hour, running all day). Mist emitters or sprinkler sprayheads would simply be changed as appropriate. Someone who knows irrigation can easily assist with selection and installation.



We are also using capillary mats to reduce water consumption. There are several brands. We have used AquaMat™. With these mats, water consumption has been reduced by about 60%, a huge savings. It also prevents virtually all runoff. The mat is layered, with heavy plastic on the bottom, then a layer of fiber fill, then drip tape and landscape fabric on the top. Pots must come into contact with the mat in order to pull up water. We have had some algae build-up and rooting into the mat. Periodic leaching is

also required to prevent salt build-up. (see Nutrition chapter)
However, on the containers that are appropriate these challenges are worth the saving in water consumption and runoff prevention.

All of these systems require controllers. These are essential if the nursery is not attended everyday. If you can afford it, controllers in the greenhouse to open vents, turn on fans, mist, and pull shadcloth are the best way to provide the perfect environment.

Use as a classroom

The greenhouse is a wonderful hands-on learning area. Students can be taught basic junior high, high school and college level



biology principles using living plants. The importance of biodiversity, biotic and abiotic growth factors, sexual and asexual propagation are constantly demonstrated in all phases of nursery production. Physics formulae and math are needed to design an efficient irrigation system. Algebra is needed



to calculate numbers of seeds to collect, germinate, transplant and outplant. Designing the greenhouse to accommodate students is helpful. Benches simply need to be spaced so students can work around them. The greenhouse must be big enough to spread out (roughly) 30 students. If there is no other indoor work area, one or two benches in the greenhouse can be covered completely and used as potting benches. If children younger than middle school are to be accommodated, then benches must be lowered to their height.

If possible all areas should be made ADA compliant. As I understand the regulations that means;

- Aisles for wheelchair accessibility – 36” wide
- Aisles must be firm, stable and non-slip –gravel not usually good enough unless mechanically compacted. There is a machine to test.
- Door width - 32”
- Working Table dimensions –
 - 48” wide
 - 28”-36” high
 - 5’ turn around radius on the side at which the volunteer will be working Can be no barrier on the edge to the wheelchair
- Outdoor paths/trails – maximum of 10% and flat rest area every 30’
- Parking spaces- a 1. and a 2. or a single 3. below
 1. Car – 8’ wide space with 5’ additional of deployment of wheelchair
 2. Van – 9’ wide with 9’ deployment area
 3. Universal parking space 11’ wide +5’ deployment
- Need firm, stable and non-slip path from pkg space to work area

HEADHOUSE - PROPAGATION AREA

It is important to have an inside area (for use on rainy days), a tool room, first aid supplies and small tool cabinet, a seed cleaning and storage area, a boiler and controller room, an office, a break area, and storage shelves area for supplies that must be kept dry.

Inside storage

Fertilizer (chemical or organic), rooting hormones, irrigation equipment, and repair parts should be kept inside. Rain gear and boots for students and staff must also be stored inside. Additionally, hoses, tarps, plastic film, construction tools and chemicals need to be stored inside. Any Class II (says Warning on the label) chemicals must be in a locked, spill-proof and vented cabinet.

Amenities

If volunteers help in the nursery, then a welcoming area and place to get out of inclement weather is needed, if you hope to retain volunteers. A sitting area is helpful along with a small kitchen facility. Of course, bathrooms should be easily accessible for all using the nursery. Food is the way to a volunteer’s (not to mention staff) heart.

Seed storage

Seeds should be dried and stored in cool conditions. Common refrigerator conditions (34-40°F) typically suffice. A walk-in cooler is used in our nursery.

Seed cleaning

A sink is essential for food preparation and for seed cleaning. A restaurant sized stainless steel sink works well. Otherwise, seed cleaning needs a table or covered bench. Most materials for cleaning are common kitchen supplies. The exception is a good set of screens (the type for soil sifting are idea) to filter seeds from chaff. A dissecting scope is very helpful both for seed counting and cleaning but also for plant identification. Although, have one is not essential. An accurate scale to hundredths of a gram is crucial to calculate numbers of seeds collected and amounts to be sown.

Work area

Benches in the propagation house are helpful. Seeds can dry out or blow away outside. Bench space needed is based on number of workers. Assume 4' x 3' of bench space per worker. 3' x 2' can be used for students or volunteers working only for 10-20 minutes at a time. Temporary work tables can be set up for very young student groups or wheelchair bound workers by using the new plastic top office tables that are 3' wide by 6' or 8' long. The legs can be folded under and put away when not in use.

Permanent benches are typically built from wood legs or are put on concrete blocks. They should have a solid surface which can be sanitized as needed. An exterior plywood top can be covered with linoleum or ideally with sheet-metal. Be sure there are no sharp edges.

Office

Even though the main activity is growing plants, an office area is essential. Careful records are kept of all seed collection, seed treatments, propagation methods and amounts, success rates, and inventory. The office will need desks, file cabinets, computers, printers, phones, modem lines or internet connection, FAX, and bookshelves. If interns have the opportunity to work in the nursery, they will need a desk area also.

OTHER OUTSIDE NEEDS

Perlite, vermiculite, propagation media should be under cover or bags will absorb water and be ruined. Pots will be useable longer if stored in the shade under cover to prevent UV breakdown.

Pallet racks work well for this storage area. But a permanent cover is needed over the racks. Remember that all the pots used through the growing year can come back to the nursery to be washed and put back on the shelf for reuse. If the nursery grows 30,000 plants per year, storage must be available for at least 30,000 containers.

Pot washing

Usually in revegetation, pots are reused. For disease prevention, organic matter that can harbor disease organisms should be removed from pots by washing. When untrained workers or volunteers are present, chlorine bleach should not be used. A large tub or farm tank or a high pressure washer works well for pot washing. Of course, water must be plumbed to the sinks or tank.

Soil bins

A clean area or bin should be kept for potting media ready to use. This should be near the work area, so filling of pots is convenient. A bin should be at least 12' wide to allow

backing of a dumptruck into the bin area. Size will determine how often soil deliveries must be made. A tarp should be used to cover the soil, keeping it free of seeds from weed species and will also prevent drying out. There should be a hose bib and water close by to keep the potting media moist.

Compost area

If you are going to compost green waste at the nursery and used potting mix, then space for a 3 bin composting system should be set aside. A hose bib will also be needed near the piles.

Handicapped accessibility.

Where possible all areas and work surfaces should be handicapped accessible. This may require paving walking areas, differing bench heights, and improving bathroom design.

Demonstration garden

A demonstration garden of the plant communities is helpful. It also provides host plants for beneficial predators and a place to utilize surplus plants. This can also be a place where students can take plant samples without depleting native habitat

And of course, the question always is, what is the cost of all of this?

ROUGH COST ESTIMATE – THE BOTTOM LINE

(2007 \$\$)

To produce 30,000-60,000 plants per year – see notes on space needed

Grading site, if needed		\$20,000
Greenhouse –	20'x50'	\$20,000
With Lexan glazing, auto sensors, shadecloth and computer controls, fans and vents		
Contractor to build –including electrical		\$30,000
Benches – expanded metal		\$8,000
Shadehouse	4,000sf	\$8,000
Contractor		\$6,000
Benches-galv metal with plastic tops		\$10,000
Mist and irrigation –parts and professional installation, greenhouse and shadehouse.		\$10,000
Graveling road access and work areas		\$8,000
Soil bin	12'x9'	\$2000
Compost bins	24'x6'	\$3000
Covered storage area	12'x20'	\$5000
Headhouse propagation area -		\$50,000
Total		\$180,000

These are very rough estimates only. Contractor costs will vary greatly. Trust construction work to volunteers only if very experienced in building. We are currently replacing structures lovingly built by volunteers that did not hold up. .

For Further Reading

The Container Tree Nursery Manual, Vol. 1, Nursery Planning Development and Management. Landis, T.D.; Tinus, R.W.; McDonald, S.E.; Barnett, J.P. Agric. Handbk. 674. Washington, SC: U.S. Department of Agriculture, Forest Service. 1990.

Appendix D
Nursery Propagule Collection and Growing Guidelines
to Avoid Genetic Degradation on Restoration Sites
(Young, B. [no date])



NURSERY PROPAGULE COLLECTION AND GROWING GUIDELINES TO AVOID GENETIC DEGRADATION ON RESTORATION SITES

GOLDEN GATE NATIONAL PARKS
Betty L Young, Program Director of Nurseries

In an ideal world, we would not plant container plants at restoration sites. It would be better to simply manage for natural recruitment of natives in sites to be restored. This is possible when there is sufficient native seedbank and the site is not subject to reinvasion by weeds. In this park we have both challenges, which make the planting of container plants, usually the most successful method. However, we take steps throughout the collection and growing season to provide the most “natural” plants possible.

There is a compelling body of evidence demonstrating the importance of using local propagule sources for restoration. A comprehensive literature review was completed by Yan Linhart, University of Colorado at Boulder. His conclusions showed the importance of maintaining local ecotypes, whether there is phenotypic variation or not. Also, research by EE Knapp and K Rice from University of California at Davis, demonstrates the ecotypic variation of species in different areas of the state.

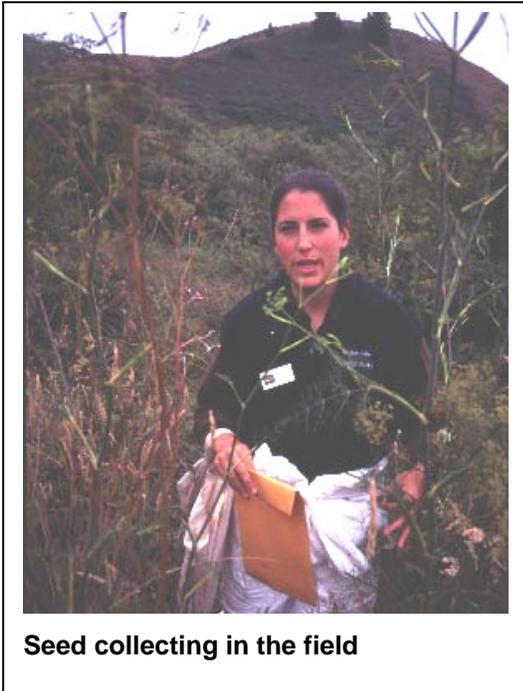
This local variation also increases the probability of survival in a project by using plants best adapted to the particular site. In the park, we normally define local as within the same watershed. We don't want to impact the local population with outside genes that may cause adverse effects. We want to preserve the unique genetic mix that has evolved at the site and is successful there. As a National Park, part of our mission is to preserve the unique genetic resource present in each species in each area of the park.

While we are collecting locally, we need to insure a broad enough to prevent genetic degradation; inbreeding, and genetic drift and allow natural selection and gene flow. In other words, we want to create a self-sustaining habitat. In order for plants to successfully reproduce and continue to evolve as the site conditions change, there must be sufficient genetic diversity within each species in the plant population at the site. When collecting within only one watershed, the collector and nursery must be careful to maintain genetic diversity within the population and avoid artificial selection in the nursery where possible. Therefore, we seek a balance, locally adapted plants, with as much genetic diversity within those plants as possible.

Seed and propagule collection

First, for these reasons, we use seed whenever possible. Unless a species is self-pollinated, each seed on a plant will be genetically different. The pollen fertilizing the ova, will be from a different male. Even if self-pollinated or if all flowers pollinated by the same male plant, each seed will be slightly different due to meiosis and the recombinant DNA in the fertilized zygote.

Just as each of your brothers and sisters is different, even when all of you have the same parents. Of course, in self-pollinated species, there is less genetic variation within a population but greater variation from one population to the next. Whereas, out crossing species will have more variation within a population but less from one population to the next. (Linhart)



Seed collecting in the field

Each of our rules for collecting is made in consideration of the above;.

- No seed is collected from the wild, except for an approved project. Please verify with the project manager that the project has received all required approvals and permits. Project Review or Restoration Acton Plan must be approved before seed collection begins.
- If a plant is to be reintroduced to an area, in which it no longer exists, a Reintroduction Plan must also be completed and approved, before planting.
- **Normally, only seed is used for propagation. It is collected from the watershed in which the project will be planted.** If there is insufficient seed source in that watershed, permission must be obtained from the Park Plant Ecologist to collect from another area. The plant ecologist may define a collection zone other than the watershed if knowledge of the species provides a better definition of “local” for that species.
- If you have not collected this species before, check the Park Restoration Database or the Nursery Manager for a description of what ripe seed looks like.
- We want to collect only the minimum amount needed to provide the requested plants for a project. Records are kept of the germination rate and survival rate in the nursery. Seeds per gram counts are kept of uncleaned and clean seed. **Calculate the number of grams of seed needed based on this information. Collection no more than this amount.**
- **Collect no more than 5% of the available seed from any species within that area.** (Unless this is a site that will be completely destroyed due to development). This leaves sufficient seed for natural regeneration in the collection area. We do not want to degrade a wildland natural remnant site for restoration. This is our most valuable habitat.
- Each project manager or nursery manager should keep records of where seed has been collected, so that no more than 5% of the seed of any species within the collection zone may be gathered. GPS collection sites where possible. Always GPS uncommon plant collection sites. Enter in Cybertracker to be GISed. We have a shareware program which allows us to use inexpensive PDAs and GPS units to fill out CNDDDB forms and GPS locations. This GPS information can be imported into a GIS mapping system.
- **Collect from as many plants of a single species as possible throughout the collection area, but never less than 10 plants, 50 plants a minimum for herbaceous species.** Do not bother to collect from only one plant. If there are fewer than 10 plants

check with the plant ecologist, about whether to use just the available 5% or to go outside the watershed. To determine collection zones, the species breeding system, pollinators and seed dispersal mechanisms are considered

- **Collect each species for the project several times throughout the seed ripening period; early, mid and late ripening seed.** We don't want all late ripening seed, that may never ripen on the site if there is an early frost. The later seed should be combined with the early and mid seed, so that not just one portion of the seed. Then a random mix of seed will be sown. There will be a range of collection dates in the records for each seed batch.
- Look at the elevation, soil, slope and aspect at the site where planting will be done. Keep this in mind when collecting. Try to collect from similar conditions if there are sufficient numbers of plants to provide a good genetic mix.
- Complete required paperwork and return to the Nursery Manager or Seed Collector for the project. Complete:
 - Propagule Collection Record for each species collected within a collection area. You may have multiple dates of collection on a record. Enter this into the Park Restoration Database.
 - Fill out a Work Record with time spent collecting the seeds.

Sometimes, seed is not used for propagation. If a plants natural breeding system is clonal, like strawberries and willows, we propagate clonally. However, methods vary even with clonal propagation. Strawberries are self-pollinating genera. We normally, therefore, collect from a single population, to avoid genetic swamping by an outside population. Usually, a discussion is held, and a decision is made based on the site characteristics. Willows are wind pollinated and therefore vary within populations. We avoid producing one of just a few clones by collecting from as many individual plants within a populations and from all possible populations in the watershed. Even though clonal, the cuttings will be variable since they came from many individuals.

Hopefully, following these guidelines will give a local but genetically diverse batch of seeds for a species within a watershed.

Seed stratification

The avoidance of artificial selection does not stop at propagule collection. Reduction in genetic diversity can readily happen through nursery growing practices. Even on the coast of California, many species of seed are adapted for a cool wet winter. Most seed is collected in the summer and fall, dehydrated, and put in dry cold storage. We must provide moist cold conditions to break seedcoat or internal dormancy of our collected seeds. We could sow seeds in the fall and let that winter's cool temperatures stratify the seeds. The seeds that obtained enough cold temperatures to break their genetically determined dormancy period would then germinate. However, we would be selecting out seed that required a longer winter than this year's. We therefore, stratify in the refrigerator, at 38-40oF, Luckily in California, typical refrigerator temperatures mirror our winter nighttime temps. Yes, ideally, we would make some night colder and some warmer. However, usually seeds need a certain number of degreehours. The warmer temperature can be overcome by stratifying longer.

Any seed that germinates over a period of time, longer than 2 weeks, indicates that more stratification was needed than was given. Even grasses, which germinate fairly well without stratification are stratified for 2-3 weeks, simply to insure that all seed in the batch have the stratification they may require.

- Record in Species Information Records a range of stratification days. Begin checking seed when the shortest time has elapsed. Once radicles emerge, sow these seed.
- Return to the Seed batch in stratification once a week and sow new emergents, until the longest strat. period has elapsed and no additional seed has germinated. Sow all remaining seed.

Seed Germination

We try to mimic as closely as possible, the conditions when the species normally germinates. We also, must time each crop to be outplantable size by November 15. We may start a seed in the greenhouse earlier that its normal germination time, by putting on a heated bench. Depending on how quickly the plant grows, it may be started on a heated bench, unheated bench in greenhouse or outside.

One of the main reasons, direct seeding in the field seldom works in California, is that the rains seldom cooperate. If there is sufficient seed source, if its rains every third day and if temperatures stay moderate, direct seeding may be successful. We typically, need only 1/10 the amount of seed to grow nursery plants as is needed to direct seed a site. The secret to this is mist in the greenhouse. We can keep seeds from drying out before and after they germinate.

Here we wait until germination stops, before transplanting seedlings. Then we have early and late germinating individuals.

Seedling Transplanting

We usually ask the smallest student in education programs, are you less healthy or robust because you are shorter than your brother or sister? Just because a seedling is small, does not mean it isn't healthy and robust. Herbaceous seeds are usually started in a flat, unless very reliable germinators. We instruct staff, interns, volunteers, and students to transplant big and small seedlings. We, normally, transplant seedlings from the germination flat to their final container, usually Steuwe and Sons Deepot 16™. This avoids multiple transplant events that can further change the already altered root structure. For woody species, grasses and reliably germinating forbs, we usually direct sown seeds in the final tube.

Leachtube 10 cu in for grasses, deepot 16 cu in for forbs, depot 40 cu in for shrubs and Treepot 4"x14" for trees. When culling extra germinates, we tell volunteers to keep the center seedling and cull or transplant to another pot any other germinants in the pot.



Volunteers transplanting seedlings

Growing on

From transplant until time for plants to go to the field, it is difficult to avoid conditions that degrade genetic diversity. In California, there is no summer water. CA species are adapted to dry summer conditions. They compensate for having little water available by mining vast areas with their root systems. Mycorrhizal associations (beneficial fungal symbiosis) expand the area from which a plant can mine water. In the nursery the plant has a little tube. We have to provide summer water. This will promote the survival of plants more adapted to having rootzone moisture. All we have found to do is provide an extremely well drained potting media, which provides moisture, but quickly drains to avoid any water-borne pathogens. We employ every cultural control we can think of to promote healthy plants; draining thoroughly between watering, spacing plants to promote air movement, intermixing crops to avoid large areas of a single tasty species, timing propagating properly to avoid a rootbound condition late in the season, compost tea, compost based potting mix, keeping plants on raised benches off of the soil, pulling weeds around the nursery and any in the pots.

We fertilize at very low rates of nitrogen, which will promote rapid vegetative growth and thin cellwalls susceptible to fungal attack. Cottonseed meal (6-2-1) and bonemeal (3-15-0) is used in the potting mix as the main nutrient sources. These both release slowly throughout the season. Very little supplemental fertilization is needed in our 6-9 month growing season.

With the exception of trees, plants are pruned to keep a positive root to shoot ratio. This promotes survival through the dry summer after planting. Since water uptake needed to avoid wilting is directly proportional to the leaf surface area. We keep that area to a minimum that will allow to the plant to maintain a healthy state.

Hopefully, with these procedures, as much artificial selection as possible has been avoided. Those few plants that were particularly adapted to nursery conditions may be planted out but would be culled in the site by natural conditions the year following outplanting.

A commercial nursery would go broke if they followed all of these guidelines. However, we who serve the national parks, have the advantage of interns and volunteers. We can use these special methods because of our strong force of dedicated volunteers who donate almost 40,000 hours to the park's five nurseries. They help collect, transplant, water, prune, cull and maintain 120,000 genetically diverse and healthy plants each year.

Volunteers grooming plants



Appendix E
Nursery Safety Manual
(Golden Gate National Parks Conservancy 2007)

NURSERY SAFETY MANUAL



Revised July 2007

Golden Gate National Parks Conservancy Policy to Insure the Safety of Employees, Interns and Volunteers.

INTRODUCTION

The safety and health of each Golden Gate National Parks employee, intern and volunteer is of primary importance to us. As a company, we are committed to maintaining a safe and healthful working environment.

The Conservancy will provide all necessary safeguards, programs, and equipment required to reduce the potential for accidents and injuries. Your responsibility is to read this manual, to follow its instructions and work in a safe manner, and to report any condition you feel is unsafe to your supervisor.

This Safety Manual is tailored as a working document to meet our unique needs as nursery and field staff. This program is designed to prevent workplace accidents, injuries, and illnesses that result from seed collection, nursery and field activities. Safety information on the safe use of most of the tools we use and activities we perform are contained in this manual. Check it before using an unfamiliar tool or piece of equipment, ask your supervisor for training and demonstration before using any tool or piece of equipment.

A copy of the program is maintained at our Nursery Main Office at Presidio Building 1216. A copy is also maintained at each nursery in the Safety Information area containing, Emergency Procedures, the Safety Manual, MSDS binders, Pesticide Labels, and other safety information. You may review it at any time and are expected to review as noted in this binder. You will be provided with relevant portions for yourself as you participate in the particular activity. You may also contact Betty Young, Program Director for Nurseries, if you have any questions or concerns.

It is the intent of Golden Gate National Parks Conservancy to comply with all laws relating to occupational safety and health, including pesticide application, fall prevention, and machine guarding. The policies and procedures contained in the following manual are **mandatory**. You should also be constantly aware of conditions in all work areas that can produce injuries or illness. No employee is required to work at a job that he or she knows is not safe. Never hesitate to inform your supervisor of any potentially hazardous situation or condition that is beyond your ability or authority to correct immediately. No employee will be discriminated against for reporting safety concerns to management.

It is the responsibility of each employee to support the company safety program and to perform in a manner that assures his or her own personal safety and the safety of others, including customers, visitors, contractors and volunteers. It is the responsibility of all who supervise volunteers to insure that they are given proper safety training and are working in a safe manner.

To be successful, all employees on every level must adopt positive attitudes towards injury and illness prevention. We must also cooperate in all safety and health matters, not only between management and employees, but also between each employee and his or her respective coworkers. Only through such an effort can any safety program be successful. Our objective is a safety and health program that will reduce the total number of injuries and illnesses to an absolute minimum. Our ultimate goal is zero accidents or job related illnesses.

Organization of Safety Manual

This Manual is organized to give information on:

1. Emergency Response Information. What to do if an emergency or accident happens.
2. General Safety. The rest of the manual will, hopefully, prevent accidents from happening.
3. Hazardous Materials Information
4. Tool and Equipment Safe Use
5. Hazards in the Field
6. Training Sheets – these are copies of the Training information in the manual along with a space to have participants sign-in after the training. These sheets are to be kept in each nursery office under Training Forms

Greg Moore, Executive Director, Golden Gate National Parks Conservancy
Betty Young, Program Director of Nurseries
Revised July 2007

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EMERGENCY PROCEDURES

In Case of a Fire

- Call 911 or 561-5505. The responsibility for fighting fires is with professional fire fighters.
- Confine the fire by closing doors
- Do not break windows.
- Alert anyone in danger. Check all work areas to ensure that everyone has been alerted.
- Activate alarm, if there is one.
- Evacuate the building via the nearest safe exit.
- Meet at the pre-designated location after evacuating the building.

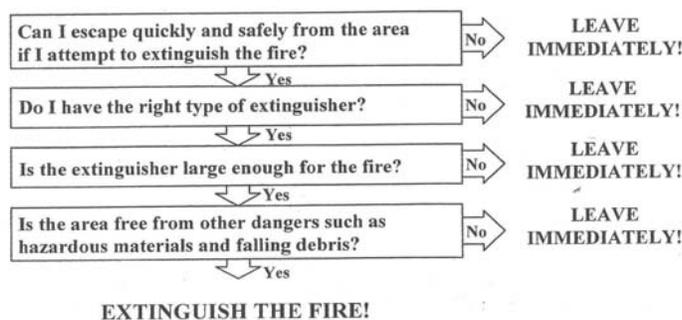
Meeting location for this nursery: _____

- Account for all coworkers.
- Be alert for approaching emergency vehicles. If you think they may not be able to find the nursery, post someone on the road. Let the nursery manager know your location.
- Use a fire extinguisher only if you have been trained in safe use.

Deciding to use a fire extinguisher

Below is a decision making guide for using a portable fire extinguisher during a fire. Ask yourself each of these questions before attempting to extinguish a fire. If you answer “NO” to any of these questions you should leave your work area immediately and if in a building, shut all doors as you leave to slow the spread of the fire.

If you answer “YES” to all of the questions, you may attempt to extinguish the fire. If you feel unable to extinguish the fire, however, than leave immediately.



Courtesy of Public Education Specialist, City of Colorado Springs Fire Department

In Case of Earthquake

- DUCK & COVER – under a heavy table, desk or in a doorway, away from glass.
- Crouch and protect your head.
- Stay away from windows and doors.
- Stay outdoors if you are outdoors.

After an earthquake:

- Weigh the risks before you do anything.
- Be prepared for aftershocks.
- Minor quakes - Stay where you are.
- Major quakes. – Exit calmly. Meet at the designated location. If evacuation is not possible, stay where you are until help arrives.
- Do not use telephone, except in an emergency.

Steps to Take During an Emergency

Golden Gate National Parks Conservancy has developed the following emergency plan to cover those designated actions that must be taken to ensure employee safety from fire and during other emergencies or disasters. Any questions about this plan should be directed to Betty Young, Nursery Program Director, 415-561-4860 or to Park Emergency line 561-5505.

Office, Nursery Structure & Warehouse Emergency Evacuation and Fire Prevention

Each nursery manager is responsible for ensuring the following:

1. That all required emergency exits are clearly identified in the office and nursery and that all required fire fighting and emergency equipment is available and in good condition.

The following items will be maintained:

- Crank Radio or portable battery powered radio and batteries.
- First aid kit
- Drinking water- two gallons per staff and intern for 3 days.
- Flashlight
- Portable battery powered radio and batteries
- Fire extinguishers
- Wrench to shut off the main gas valve
- Pry bars, axes, saws, tools or similar devices for employee rescue

- Food (such as high energy Power Bars) supply for three days. Assume you may have a class of 30 students to protect and care for when disaster strikes.
2. Creating a facility map designating all emergency evacuation routes, a meeting place, and the locations of all fire fighting equipment and emergency supplies and equipment. These maps will be posted in at least two locations in the facility.
 3. Designate a meeting area in case of emergency evacuation. Be sure all employees, interns and volunteers know its location.
 4. Training all exposed employees on the procedures to be followed in the event of fire, earthquake or other emergency including how to properly notify other affected employees.
 5. Identifying potential fire hazards in the office, nursery and work areas and ensuring that adequate steps are taken to prevent fires.
 6. Ensuring that combustible trash and materials are removed promptly from the facility, and that all flammable and combustible liquids are properly stored and handled.

During an Emergency

In the event of an emergency such as earthquake or fire, all employees are expected to evacuate the premises immediately. Call **911 or 561-5505** if emergency is at your local site. Each nursery manager will be responsible for shutting off the gas or electricity, or if needed, may assign some employees the task. At no time will any employee be expected to jeopardize their own safety to do this.

Employees will be notified of emergencies through one of the following:

- Fire alarm
- Intercom
- Emergency horn
- Direct voice communication
- Cell phone call to managers. Managers carry cell phones at all times.

After the emergency evacuation has been completed, a head count will be taken to ensure everyone is out of the building.

If necessary, Nursery manager may assign some employees to rescue trapped employees. But under no circumstances should an employee put him/herself in danger to rescue someone trapped. Call the professionals.

First Aid Tips and Accident Procedures

Each staff member and intern who leads a program must keep a current first aid and CPR certification. This training is provided at no cost by the NPS, contact 561-4860 or 497-5671 to sign up.

All nurseries will be equipped with necessary basic first aid supplies to attend to injured employees and volunteers. For all serious injuries or when staff is not on site, Call Park dispatch 561-5055 regular, 561-5565 for Emergencies, or 911 from nursery phone lines. For less severe injuries ask your immediate supervisor for assistance or Betty Young, Nursery Program Director. In the event of a sudden accidental injury or illness the following tips will help prepare you to offer basic first-aid assistance:

- **Shock-** Signs of shock may include: pale, cold skin, fast or faint heartbeat, and victim confusion. *Care for shock:* Place victim on their back with both feet raised about 12 inches, cover the victim to maintain body temperature, and do not give the victim anything to eat or drink.
- **Bleeding-** To treat external bleeding, apply direct pressure to the wound with a clean gauze patch or cloth and elevate the injury above heart level if possible. If a bone is broken, immobilize the joints above and below the break before elevating the wound. Look for signs of shock.
- **Bandaging-** Clean the wound with mild soap and water, place a clean bandage over the entire wound and secure with tape, check that the bandage is not too tight by checking circulation of the area below the bandage.
- **Sprains and Fractures-** First control any bleeding, if a bone has broken through the skin, cover the wound with loosely wrapped gauze or cloth and apply pressure around the injury but not directly on the bone, place ice or a cold pack on the injury for at least 20 minutes and raise the injury above the heart to reduce swelling, immobilize the injury by placing a splint next to the injury (be sure the splint is not too tight).
- **Burns-** First stop the source of the burn by removing the heat source and smothering flames, clean first and second degree burns with mild soap and water, don't break any blisters, cool the skin using cold (not ice) water by submerging the burn or holding the injured area under running water, bandage the burn with a clean, dry dressing held loosely in place.
- **Chemical exposure-** *Skin exposure:* Stop the source by removing the victim from the spill area, take off any clothing that has been exposed to the chemical, using gloves brush water activated chemicals, such as Lyme, from the skin, flush the affected skin with cool water for at least 15 minutes. *Eye exposure:* Flush the affected eye(s) with cool water for at least 15 minutes. *Airway exposure:* Take the victim to fresh air and perform rescue breathing or CPR if needed.
- **Poisonings-** Do Not Induce Vomiting Unless the Label Indicates - transport the affected person to the medical clinic immediately for treatment or call 911. They will take the appropriate action, for poisonous bites: keep the victim still with the injury positioned below their heart level, call 911, and treat for shock if needed. For rattlesnakes, do not apply a tourniquet or ice to effected area; do not cut the bite area or attempt to suck the venom out with your mouth. For questions regarding a poisonous compound call 1-800-8poison.

First-Aid Kits

Every job site and vehicle shall have access to at least one first-aid kit in a weatherproof container. The first-aid kit will be inspected regularly to ensure that it is well stocked, in sanitary condition, and any used items are promptly replaced. The contents of the first-aid kit shall be arranged to be quickly found and remain sanitary. First-aid dressings shall be sterile and in individually sealed packages. The following minimum first-aid supplies shall be kept:

Type of Supply Required by Number of Employees

Dressings in adequate quantities consisting of:

Adhesive dressings		
Adhesive tape rolls, 1-inch wide		
Eye dressing packet		
1-inch gauze bandage roll or compress		
2-inch gauze bandage roll or compress		
4-inch gauze bandage roll or compress		
Sterile gauze pads, 2-inch square		
Sterile gauze pads, 4-inch square		
Sterile surgical pads suitable for pressure dressings		optional
Triangular bandages		
Safety pins		
Tweezers for tick removal		
Scissors		
Cotton-tipped applicators*		
Forceps*	X	X
Flashlight*	X	X
Magnifying glass*	X	X
Appropriate record forms*		
First-aid textbook, manual or Equivalent*		

*To be readily available but not necessarily within the first-aid kit.

Accident Reporting Procedures

For employees:

1. Determine if your injury requires emergency assistance

If an emergency call 911 immediately. If on Park Land, the 911 call will be answered by Park Police dispatch and paramedics will be dispatched at once. Tell them exactly where you are located and an employee of Golden Gate National Parks.

If this is not an emergency, and you need medical attention, you must report to an approved Workers' Compensation authorized medical center. See attached list. Report to your manager-see below. Call clinic first to schedule an appointment. Tell your manager which facility you are going to and the date and time of your appointment. Your Employer Contact is Holly Chrobak, 561-3061.

2. Report your injury immediately

All injuries must be reported to your manager immediately, whether you require medical attention or not. If your direct manager is not on site, you must inform another on site manager or Betty Young at 561-4860. If there is not another manager on site, you must telephone or page a

manager immediately. If you are not able to reach a manager, notify your manager the next morning.

3. Paperwork to Complete

You must make arrangements with your manager to complete paperwork with the Human Resources Department at Fort Mason. This must be done within two working days (weekends excluded) of your accident.

4. Read the posted Workers' Compensation notices.

You will find them posted in your designated employee area.

For volunteers:

1. If life threatening, **CALL 911 Or 561-5656 if in the Park**
2. If not, render first aid if needed.
3. Be sure volunteer is ok. If they need to go to the doctor immediately, have them take the form below with them. If you can, fill out the Supervisor's Report section. Tell them to fill out the rest of the form and send to Winnie Fong NPS Human Resources Department in Building 201 Fort Mason, the doctor doesn't need it.
4. Drive them if there is any question about their ability to drive. If they don't have a regular doctor, have them call any doctor. Let the VIP choose. Have that doctor call Winnie Fong for verification of coverage. Call Winnie Fong immediately so she is alerted before the call comes in.
5. Be sure you have an "AGREEMENT FOR VOLUNTARY SERVICES" for adult and PARENTS' PERMISSION FORM FOR CHILD on file. If a child comes to volunteer without a Parents Permission Form, only allow them to do something which cannot possibly cause injury.
6. If the VIP doesn't need to go to the doctor immediately, help them fill out US Dept of Labor form:
Federal Employee's Notice of Traumatic Injury and Claim for Continuation of Pay and Compensation.
Form #CA-1

There is a section for the VIP to fill out and a Supervisor's Report for you to fill out.
7. Call Winnie Fong, GGNRA personnel office in Bldg 201, Ft Mason, 561-4772 immediately, and let her know. Get her the form as soon as humanly possible. She will assign a claim number, and verify to any doctor or hospital about the coverage.

Volunteer takes that claim number to their own doctor, gets treated and the doctor bills the park's workers comp carrier.

Fire Prevention at Nursery Sites

The following procedures will be used to prevent fires at GGNPC nurseries:

- All accumulated combustible trash and debris will be removed as soon as practical.
- Flammable liquids will only be stored and dispensed from UL approved safety containers designed for that purpose.
- All rags soaked with flammable or combustible liquids will be properly stored in closed metal containers.
- Appropriate precautions will be taken to prevent fires when torch cutting, welding or soldering.
- Compressed gas cylinders containing flammable or explosive gasses will be properly stored in the upright position with their caps on and protected from heat or puncture. Fuel gas and oxygen shall be separated at least 20 feet when stored.
- Smoking or open lights are prohibited within 50 feet of flammable liquid or gas storage and dispensing areas.
- Flammable solvents will not be used for cleaning purposes.
- Our fire extinguishers are all ABC and can be used on the following fire types: solid materials, flammable liquids, and electrical equipment. This type of extinguisher meets all requirements for potential fire hazards in the nurseries.
- A fire extinguisher should be available within 75 feet of any area you may be working in the nursery as well as in each vehicle.
- An additional fire extinguisher should be available at least 25 feet but not more than 75 feet from any flammable liquid storage. It should not be more than 10 feet from any door to a room containing flammables.
- Portable fire extinguishers shall be inspected monthly, or at more frequent intervals by the employer, and serviced at least annually by a person licensed or registered by the State Fire Marshal. NOTE: Inspection is a "quick check" that an extinguisher is available and will operate. It is intended to give reasonable assurance that the extinguisher is fully charged and operable. This is done by seeing that it is in its designated place, that it has not been actuated or tampered with, and that there is no obvious or physical damage or condition to prevent operation.

GENERAL SAFETY

General Safety Rules for a Safe Workplace

The Golden Gate National Parks Conservancy wants to keep all employees working in the safest possible environment. To achieve this goal, employees must do their part by following these safety rules.

1. All persons shall follow these practices and render every possible aid to safe operations.
2. Failure to abide by these practices may result in disciplinary action up to and including termination.
3. Immediately report any unsafe conditions, accidents, injuries or illness to your supervisor. If you are unsure of the safe method to do your job, STOP and ask your supervisor. Ignorance is no excuse for a safety violation.
4. No one shall be knowingly permitted to work while the employee's ability or alertness is impaired by fatigue, illness, and prescription or over the counter drugs. Employees who are suspected of being under the influence of illegal or intoxicating substances, impaired by fatigue or an illness, shall be prohibited from working.
5. Never work while under the influence of an illegal or intoxicating substance, fatigued or ill.
6. Anyone known to be under the influence of any drugs or intoxicating substances which impair the employee's ability to safely perform the assigned duties shall not be allowed on the job.
7. Horseplay, scuffling, fighting and other acts which tend to have an adverse influence on the safety or well-being of the employees are prohibited.
8. Work shall be well planned and supervised to prevent injuries in the handling of materials and in working together with equipment.
9. Keep your work area clean, free of debris, electrical cords and other hazards.
10. Immediately clean up spilled liquids.
11. Always notify all other individuals in your area who might be endangered by the work you are doing.
12. Do not operate equipment that you are not familiar with. Do not attempt to use such equipment until you are fully trained and authorized.
13. You are responsible for ensuring all safety guards are operable and in place. If they are not, STOP working and tell your supervisor.
14. Never bring firearms, weapons, illegal drugs or alcoholic beverages on company or customer property or the job site.

15. A red tag system identifies equipment that is NOT to be operated, energized or used. All tag-out or lockout notices and procedures must be observed and obeyed.
16. Do not block exits, fire doors, aisles, fire extinguishers, first aid kits, emergency equipment, electrical panels, or traffic lanes.
17. Do not leave tools, materials, or other objects on the floor that might cause others to trip and fall.
18. Do not run on the job site or in the shop or office area.
19. Do not distract others while working. If conversation is necessary, make sure eye contact is made prior to communicating.
20. Employees shall ensure that all guards and other protective devices are in proper places and adjusted, and shall report deficiencies promptly to the Supervisor.
21. Tree branches may not be discarded from trees until proper precautions are taken to protect others from the falling objects.
22. Employees shall cleanse thoroughly after handling hazardous substances, including pesticides and insecticides, and follow special instructions from authorized sources.

Office Safety

Office accidents can and do happen. To prevent them, Golden Gate National Parks Conservancy has developed the following rules for our office staff. We will also endeavor to include office employees in periodic safety meetings. If at any time, you feel there is a safety hazard, or you have any safety concerns, please do not hesitate to notify Betty Young or Robyn Hettrich, Director of Personnel.

1. Report all accidents and injuries, no matter how minor, to your supervisor immediately.
2. Correct or report any safety hazards that you observe.
3. Clean up any spilled material that may present a slipping hazard.
4. Do not stretch any cords across aisles that may present a tripping hazard.
5. Use a step stool or ladder for hard to reach items, do not attempt to climb on shelves or stand on chairs.
6. No one shall be in the possession of, or under the influence of, alcohol or controlled substances while on the premises.
7. Close file drawers when not in use and do not open more than one file drawer at a time. This could cause the cabinet to tip.
8. Do not store heavy objects above your head which could fall on you in an earthquake.

9. Do not store flammable or combustible materials near heaters or other heat sources.
10. Always follow safe lifting procedures when lifting any object and get help for heavy loads.
 - Bend your knees, not your back.
 - Keep the load close to body.
 - Keep your back straight.Lift with your legs. Do not lift and twist.

General Ergonomics Tips

Studies have shown over the years that poorly designed and arranged work areas, awkward work postures and repetitive motions can lead to a variety of injuries including carpal tunnel syndrome and tendonitis, which are often referred to as repetitive motion injuries (RMI's). As with cancer, heart disease, and many other ailments, there are risk factors that increase an individual's likelihood of developing RMI's. If the risk factors are reduced, so are the chances of being injured. While some of these risk factors, such as family history, cannot be controlled in the employment setting, many can. Including:

- The force used to perform a task,
- Posture while performing tasks,
- The number of repetitions performed in a given time period, and
- Mechanical stresses such as hard surfaces.

Golden Gate National Parks Conservancy has developed the following program designed to minimize RMIs. The program includes worksite evaluations, control of exposures that have caused RMIs and training of employees.

Worksite Evaluation and Exposure Reduction.

Each job, process, or operation of identical work activity that has resulted in at least two RMI's or a representative number of such jobs, processes, or operations shall be evaluated for exposures that have caused RMIs. Golden Gate National Parks Conservancy may request assistance from outside consultants for this purpose. If you have questions regarding equipment or functions in your office area please contact the personal office at 561-3061 for an on site review.

Any exposures that have caused RMIs shall, in a timely manner, be corrected or if not capable of being corrected have the exposures minimized to the extent feasible. We shall consider engineering controls, such as workstation redesign, adjustable fixtures or tool redesign, and administrative controls, such as job rotation, work pacing or work breaks.

Training

Affected employees shall be provided training that includes an explanation of:

- Golden Gate National Parks Conservancy program;
- The exposures which have been associated with RMIs;
- The symptoms and consequences of injuries caused by repetitive motion;

- The importance of reporting symptoms and injuries to their supervisor; and
- Methods used to minimize RMIs *

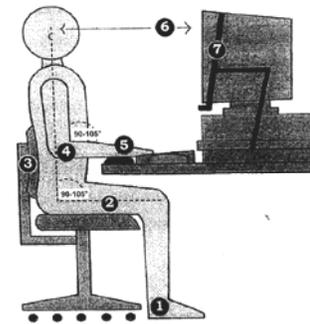
* This will include team lifting with heavy objects, such as landscape rocks, shrubs, trees, dirt, sand and gravel.

Office Ergonomics

The most significant RMI risk factor in office environments is poor body posture caused by improper workstation design or layout. In many cases employees are required to work in awkward positions for long periods of time. This greatly increases the likelihood of injury. Fortunately, this is often the easiest problem to correct. The goal is to perform work in neutral posture as much as possible. Neutral posture is best described as the most comfortable position and usually involves little or no twisting or deviation of the joints.

To apply the principle of neutral posture to the office setting we need to look at the five major components of office workstations. They are: the chair, the computer keyboard, the desk, the computer monitor, and the work product.

Chairs are often the most overlooked piece of office equipment, yet they are the single most important item from an ergonomic standpoint. A poor chair that lacks adjustments and support makes it almost impossible to work comfortably and in neutral posture. Good office chairs are fully adjustable including:



- Chair height.
- Height of the back rest.
- The position forward or back of the backrest.
- The position forward or back of the seat pan.
- The angle (tilt) of the seat pan.
- If armrests are provided, they should be height and width adjustable.

1. Chair height- In many cases, fully adjustable chairs are provided for employees, but they never adjust them. Make sure you understand all of the adjustments your chair has and how to use them. A properly adjusted chair should allow your feet to rest comfortably on the floor without putting pressure on your lower thighs. Your knees should be approximately the same height as your hips, or slightly higher, and they should be able to sit back against the backrest which is positioned for low back support.

2. Keyboard Position- Once the chair is properly adjusted, the next step is to position the keyboard to minimize bend in your wrists. In order to accomplish this, it is often necessary to have a position and height adjustable keyboard tray attached to the underside of the desk. The height of the keyboard should be set so that there is approximately a 90-degree angle between the upper and lower arms. There should also be a straight line from the elbow out through your fingers. If your fingers hang down too much or bend up, creating a “V” between your hand and forearm, you place extra stress on your wrist. The keyboard tray should also be adjusted so that you do not have to reach forward too far to type. Your elbows should be close to your side and back by your spine, not out in front of you. Do not extend the small legs on the bottom of the keyboard tray. This increases the wrist angle unnecessarily.

3. Desk Position- After you have adjusted the chair and keyboard tray, try using your desk. You should be able to comfortably write and use your other office equipment such as the calculator and phone. Some of these items may need to be moved closer to you. Your legs should also fit easily under the desk. Often, stored items such as boxes block this and should be removed. The standard desk height is fine for most people. If you are exceptionally tall or short, however, adjusting the desk up or down an inch, if possible, may be helpful.

4. Computer Position- Now you are ready to position your monitor, which should be directly in front of you. Monitors that are off to one side cause you to turn your neck that can lead to injury. The top of the screen should be at about eye level. If the screen is too low your neck will ache from constantly looking down. Monitors can easily be raised by putting old phone books or reams of copy paper under them. Tilt the screen so that the top is closer to you than the bottom, this will reduce glare from overhead lights. If you can't get away from outside light, use a glare screen to improve contrast and reduce eye strain that can cause headaches. Also know how to adjust the screen contrast and brightness controls and keep the screen clean and free of dust and fingerprints.

The risk factors of force, repetition, and mechanical stress are also controllable in an office environment. Force can be reduced by using automatic staplers and date stamps. If heavy files, boxes, or other items must be moved, use carts and dollies. When filing, use two hands to hold the larger files and keep heavy items stored between knee and shoulder height to reduce strain on your back and arms.

Repetition is controllable through the use of task management. Break up the work as much as possible throughout the day. If possible, do not spend more than two hours at a time typing or entering data. Intersperse other tasks such as filing to use other muscle groups. You should take ten-minute breaks every two hours if you are doing repetitive tasks.

Mechanical stress occurs when you rest parts of your body against hard or sharp objects. This cuts off blood flow and presses on nerves, which can lead to numbness and tingling. Sharp edges can be padded or cushioned where needed to reduce this.

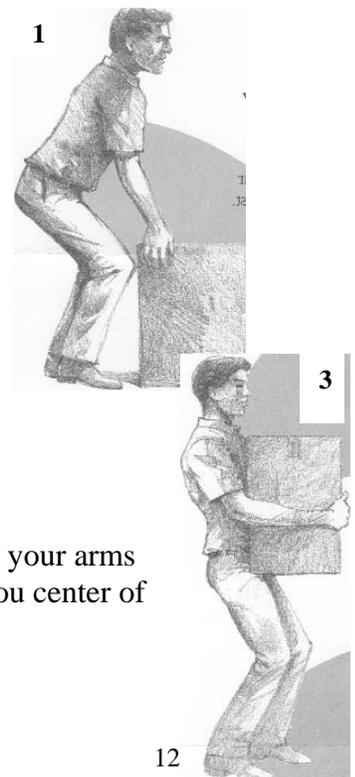
Lifting Techniques for Back Safety

1. Assume a safe lifting position- Squat by bending the hips and knees, keeping the ears, shoulders, and hips, in a generally straight line, perpendicular with the floor or ground.



2. Keep your back in its natural curve - Don't bend your back.

3. Use your legs for lifting - Control the load with your arms and upper body and keep the load close, near you center of gravity.



Before making a lift, make sure:

- The load is stable.
- There are no points to cause an injury and /or dropping the load.
- You have good visibility and have a clear path for moving the load.
- You turn with your feet to move the load, not with your waste.

To unload:

- Bend your knees and lower your body with the load while keeping your back straight. Do not bend over with the load.
- Keep your fingers clear of the bottom of the load.
- If unloading onto a rack or table, set the load on the edge and then push slide it back or over.

Field Ergonomics

The best way to avoid injury while engaging in repetitive motion activities in the field is to alternate work activities every 20 minutes when using tools or techniques while planting. Between activities, walk around for 30 seconds and stretch areas of the body that you have been using. An example scenario for nursery workers: 4 people are planting 500 plants in one day.

- First lay plants out for everyone to plant in 1 hour (4 ppl x 20 plants= 80 plants).
- Vary planting tool or technique while planting (i.e. switch between handpick and shovel every 20-30 minutes and work as a two person team, alternating tasks between planting and digging).
- Stand and stretch target muscles every hour.
- After 80 plants are planted, stop and get more to lie out.
- Continue this pattern or break up the day's activities even more with other tasks.

Below are practices to further ensure that injury due to improper field techniques can be prevented:

Hand pick use

- Keep wrist straight and work from the elbow/shoulder
- Keep target area in close range of the body in order to prevent overextension
- Use knee pads to protect sensitive knees
- Use padded gloves or padded handle in hard soils
- Specific Stretches: hand/wrist, thumb

Shovel/digging bar

- Change activity every 5 minutes for digging bar
- Use strength of legs and whole body
- Specific stretch: pectoral

Pick mattock use

- Best posture: arch back, stick butt out, stand with legs apart, engage stomach muscles
- Change activity every 10 minutes to a standing position activity
- Specific stretch: back

Carrying plant racks/buckets

- Use gloves
- Carry lighter loads and make more trips
- Carry load in arms in front of body

Requirements for Record Keeping

Betty Young, Nursery Program Director will insure the maintenance of all Safety Manual and records, for the listed periods. Nursery Managers will make sure that new employees and interns that they supervise read the manual, sign the Receipt, and give all forms to Betty. Safety records will be kept on file for the following duration of time:

- | | |
|--|----------------------|
| 1. New Employee Safety Orientation forms for | length of employment |
| 2. Nursery Safety Manual Receipt | length of employment |
| 3. Disciplinary actions for safety | 1 year |
| 4. Safety inspection Checklists | 2 years |
| 5. Tailgate or toolbox meeting reports | 2 years |
| 6. Safety Contact Reports | 2 years |
| 7. Accident investigations | 5 years |
| 8. Cal/OSHA log of injuries | 5 years |
| 9. Inventory of Hazardous Materials | forever |
| 10. Employee exposure or medical records | forever |

Records are available for review at Betty Young's office, Presidio Building 1216, (415)-561-4860.

HAZARDOUS MATERIALS INFORMATION AND SAFE USE

Chemical and Hazardous Materials

It is important that all of our employees understand the information given about hazardous materials. If you have any questions regarding this, please ask your supervisor or contact Betty Young at 415-561-4860.

This material has been prepared to assist our employees in better understanding the hazardous materials which they commonly work with.

Chemicals can enter the body in a number of ways, including inhalation, skin contact or ingestion. The hazard of any substance is dependent on other variables such as age, sex and health of the employee as well as the concentration and duration of exposure. In other words, the same amount of a chemical may produce very different effects on two different people.

Chemicals are controlled in the workplace in such a manner so as to keep exposures below a level that may produce a reaction in very sensitive people. These levels are set by the government in the interest of minimizing harmful health effects of chemicals in the workplace. The Occupational Safety and Health Administration (OSHA) have established specific legally enforced permissible exposure limits (PEL) for hazardous substances in the workplace. The PEL indicates the concentration of airborne contaminants to which nearly all workers may be exposed to for eight hours a day, forty hours a week, over a working lifetime of 30 years, without adverse health effects.

Additional information on the materials you may be exposed to can be found in the product's Material Safety Data Sheets (MSDS). A complete folder of MSDS is available to you at all times in the office and at each nursery.

At any time, an employee has the right to:

- Access the MSDS folder, and the Hazard Communication Program.
- Receive a copy of any chemical sampling data collected in the workplace.
- See their employment medical records upon request.

Understanding MSDS's

Any new potentially hazardous chemical product introduced to a GGNPC nursery must have an associated MSDS on file. Obtaining a new MSDS should occur once a new hazardous product is purchased, and may be provided by the chemical manufacturer at the time of first order and anytime the MSDS is revised or can be requested at anytime from the manufacturer. In addition to having appropriate MSDS's on hand, it is necessary to understand the format used to describe the hazardous aspects of chemical products used and stored in your nursery. Because there is not a prescribed format for MSDS contents, MSDS's from various manufacturers may vary in organization and appearance. However, each MSDS will contain the required information to understand the properties of

MATERIAL SAFETY DATA	
SECTION 4 - FIRST AID	
First Aid:	Flush with large amounts of water for at least 15 minutes. Do not induce vomiting; drink plenty of water. Remove affected person to clean fresh air. **If any of the symptoms persist, seek medical attention immediately.
SECTION 5 - FIRE FIGHTING MEASURES	
Flammable:	Non-combustible
Extinguishing media:	Use extinguishing media appropriate to the surrounding fire.
Hazards:	None
Protective equipment:	Wear full bunker gear including positive pressure self-contained breathing apparatus.
SECTION 6 - ACCIDENTAL RELEASE MEASURES	
Procedures:	Avoid creating airborne dust. Follow routine housekeeping procedures. If sweeping is necessary, use a dust suppressant. Do not use compressed air for clean-up. Personnel should wear approved respirator. Avoid clean-up procedures that could release dust.
SECTION 7 - HANDLING AND STORAGE	
Limit use of power tools unless in conjunction with local exhaust ventilation. Frequently clean the work area with HEPA filtered vacuum or HEPA filtered air. Do not use compressed air for clean-up. This product is stable under all conditions of storage. Store in a cool, dry place.	

the associated chemical and certain components of MSDS's should be included on each sheets such as:

Product and Company Identification: This section provides the name, address, and contact number of the manufacturer as well as the product name, synonyms, chemical family, and the chemical formula. Other information that may also be provided such as a registration number, code number, MSDS number, and the date the chemical was prepared.

Hazardous Ingredients/Chemical Composition Information: This section lists each hazardous component comprising more than 1% or more of the product or 0.1% if the component is a carcinogen. Also included in this section, if available, are the permissible exposure limit (PEL), recommended exposure limit (REL), and/or the threshold limit value (TLV). PEL is listed in ppm of air and is time weighted on an average eight hour day, a short term PEL may also be provided (STEL), which lists a 15 min time weighted average that should not be exceeded.

Physical/Chemical Properties: This section will include a physical description of the chemical (i.e. color and odor) as well as chemical properties such as pH, specific gravity, vapor density, vapor pressure, boiling point, melting point, solubility in water, and other pertinent physical data.

Fire and Explosion Hazard Data: This section provides information regarding the flammability of the chemical and information for fire fighting measures. Sub-points may include: flashpoint, auto ignition temperature, flammable limits, extinguishing media for the material, fire-fighting procedures such as equipment and methods to limit fire hazards, and fire or explosion hazards, which includes definitions of conditions that may cause fire or explosions.

Health Hazard Data: This section defines medical signs and symptoms (health effects) associated with normal exposure or overexposure to the chemical and may also included information about the toxicity of the substance which is listed as the lethal dose 50 (LD50). This section may also distinguish the effects of acute and chronic exposure to the chemical substance.

Reactivity Data: This section lists information regarding the chemical stability of the substance and proper storage or use considerations. Possible sub-categories may include: stability (unstable indicates that the substance may breakdown spontaneously under normal condition causing fire or explosive hazards. Conditions to avoid these hazards will be provided), incompatibility with other chemical substances, hazardous decomposition products, and hazardous polymerization effects with conditions to avoid.

Disposal and Spill and Leak Procedures: This section outlines procedures for spill and leak clean up and appropriate waste disposal for safety and environmental protection.

Personal Protection Information: This section provides information about appropriate personal protection equipment to be used while handling the chemical substance which may include: eye protection, skin protection, respiratory protection, and ventilation procedures.

Handling and Storage: This section will include information about the proper storage of the chemical material such as: minimum/maximum storage temperatures, handling procedures to minimize risks of accidental exposure, and appropriate storage procedures.

HMIS Label System

This labeling system is used for all Technical Urethanes and uses a numerical rating system of 0-4 to designate product hazard levels with 0 denoting the lowest degree of hazard and 4 indicating the most severe hazard level. There are four main categories listed on a HMIS label which are distinguished by a color coded system: health (blue), flammability (red), radioactivity (yellow), and protective equipment requirement (black text on white background). The key to each rating is as follows:

HEALTH	2
FLAMMABILITY	3
REACTIVITY	0
PROTECTIVE EQUIP.	G

Health

- 4-** Deadly, even a slight exposure could be life threatening, take extreme caution and use only specialized protective clothing when handling.
- 3-** Extreme danger, serious injury can occur from exposure to this material, do not expose body surfaces to this substance.
- 2-** Dangerous, health hazard can occur from exposure, use indicated protective measures.
- 1-** Slight hazard, minor health hazards can occur from exposure, use indicated protective measures.
- 0-** No hazard, this substance does not pose a significant health risk.

Flammability

- 4-** Flash point below 73°F (23°C) and boiling point below 100°F (38°C). Very flammable, volatile, or explosive, extreme caution should be taken in handling and storage of this material.
- 3-** Flash point below 200°F (93°C). Moderate heating condition could ignite this substance, use caution when handling.
- 2-** Flash point below 100°F (38°C). This substance is flammable, volatile, or explosive under almost all normal temperature conditions, use great caution in storage or handling.
- 1-** Flash point above 200°F (93°C). This material must be pre-heated to ignite, includes combustible solids.
- 0-** Substance will not burn.

Reactivity

- 4-** May detonate, these are substances that can detonate or explode at normal temperatures and pressures.
- 3-** Explosive, substances that can detonate or explode when exposed to strong initiating sources such as heat, shock, or water.
- 2-** Unstable, violent chemical changes possible at normal or elevated temperatures and pressures or when mixed with water.
- 1-** Normally stable, substances that may become unstable at elevated temperatures and pressures or when mixed with water.
- 0-** Stable, substances will remain stable when exposed to heat, pressure, or water.

Other important recommendations to keep in mind when using hazardous and/or chemical materials include:

- The use of applicable personal protective equipment (PPE), many examples include:
 1. A Respirator as a barrier to chemicals that can be inhaled.
 2. Gloves, facemasks, protective clothing, and head protection as a barrier to skin.
 3. Eye protection such as goggles as a barrier to eyes when pouring or handling chemicals that may splash and while spraying adhesives and paints.

- Avoid swallowing hazardous materials and chemicals; remember that this can occur by accident. Always wash hands after handling hazardous materials before eating, smoking, or drinking and make sure that all materials are properly labeled to prevent accidental ingestion.
- Do not mix chemicals without first consulting all MSDSs.
- Store all chemical and hazardous materials properly in suitable and labeled containers; also be sure to label any secondary containers. Only use chemicals in a well ventilated area.

Personal protective equipment acts as a barrier to the routes of entry that a chemical may take into your body. As a barrier to chemicals that can be inhaled, there are a variety of respirators that may be used. The respirator either filter out particles, react with chemicals to neutralize them, or provide fresh, filtered air. There are two important things to remember about using respirators. The first is that a respirator only works when you wear it and use it properly. Second, and equally important, is that you must use the proper respirator for the specific hazard. Respirators designed for one type of chemical will not work for another. One last note about respirators is that no one is allowed to use any respirator without proper training. It is against the law to use a respirator without formal training in its proper use.

As a barrier to skin, we have gloves, facemasks, protective clothing, and head protection. A combination of these items may be necessary to provide the proper level of protection in your area.

As a barrier to the eyes, a variety of eye protection may be used. Goggles are recommended when pouring or handling chemicals which may splash the eyes. They are also recommended while spraying adhesives and paints. Protect your eyes; your vision is priceless and irreplaceable.

There is no real protection against swallowing materials except good work practices. Always label any container to prevent accidental drinking. Never use old food containers to store chemicals, even if you label the container. Always thoroughly wash your hands with soap and water before eating, drinking or smoking. Keep any food and cigarettes away from the work area. Breads, fruits, and cigarettes can actually absorb chemicals from the air, to be inhaled or ingested later.

Prolonged exposure to excessive noise can cause permanent hearing damage. For those employees working in areas where excessive noise is generated, it is recommended that earplugs or ear muffs be used on a regular basis. At times, even double ear protection may be recommended.

The provisions set forth by the Federal Hazard Communication Program dictate that all containers of hazardous materials must be properly labeled. All containers of hazardous materials used must have, at a minimum, the original label provided by the manufacturer or a locally prepared label describing its contents and hazards involved. **If a substance is not in its original bottle or if the label is lost, it must have a HMIS label** (as shown above). Labels are available at each nursery; check the MSDS to fill in the rating numbers.

Personal Protective Equipment (PPE)

Wearing the proper clothing and personal protection equipment (PPE) can prevent injuries while working in the nursery or the field. Read the training information for the appropriate piece of equipment you will use or substance to apply while performing work duties for the nurseries. If the PPE is not listed in the training information or on the label of a product being used, ask your supervisor for assistance.

- Use the correct PPE for each job assignment. If you don't know, ask.
- PPE shall be maintained in good condition and cleaned regularly.
- PPE shall be stored properly when not in use to protect it from damage.
- Damaged or broken PPE must be returned to your supervisor for replacement.
- Hard hats must be worn on construction job sites at all times.
- ANSI approved safety glasses must be worn when working with power tools, compressed air or gasses, chemicals or any other item that creates an eye injury hazard.
- Face shields with safety glasses are must be worn when grinding or working with hazardous chemicals.
- Employees must wear work boots or closed toe shoes in the nursery and field that will protect them from hazards. The shoes must have complete leather uppers and skid resistant soles and be in good condition. Steel toe protection is recommended if working with heavy objects.
- Hearing protectors must be worn when working with loud equipment such as brushcutters, power lawn mowers, chain saws and leaf blowers.
- Be sure the protective clothing you wear will not hamper or restrict freedom of movement due to improper fit.
- Long pants of heavy-duty material must be worn so as to protect against branch cuts and poison oak. No shorts or sweat pants are allowed when in the field.
- Do not wear loose, torn or frayed clothing, dangling ties, finger rings, dangling earrings, jewelry items, or long hair unless contained in a hair net, while operating any machine which could cause entanglement.
- If required, wear NIOSH approved respirators when applying adhesives, paint, welding, grinding, working with chemicals, or cleaning up mouse or pigeon droppings. Read the MSDS to find out which types of respirators are required. Facial hair may not be permitted in certain circumstances.

Respiratory Protection Program

Occasionally our work may necessitate the use of respirators to protect against air contaminants found in the application of pesticides and insecticides or in areas where Hanta Virus may be present in rodent feces.

Whenever respirators are required to be used to control exposure to pesticides and other harmful agents, only respiratory equipment approved for that purpose shall be used and such equipment shall be approved by the National Institute for Occupational Safety and Health (NIOSH). Only parts approved for the specific respirator system shall be used for replacement.

Golden Gate National Parks Conservancy will provide respirators and training when necessary at no cost to nursery employees. Prior to fit testing, a medical evaluation by a licensed healthcare professional will be provided to determine the employee's ability to use a respirator to ensure the safety of the employee while using this equipment.

The respiratory protection program for GGNPC nurseries is administered by Betty Young, Nursery Program Director, who is qualified by training and experience. Yearly respirator training and fit testing is provided by the National Park Service Industrial Hygienist. Additional information and details of the program and medical evaluations can be requested from Betty and are located in the GGNPC safety manual.

Respirator Selection

As noted above, the GGNPC is responsible for identifying work areas that may necessitate the need for a respirator as well as the type of respiratory required for a potential hazard. Listed below are the types of respirators used for hazardous operations; when working in an area with a known or unknown respiratory hazard, this guide can be used to properly identify a respiratory to ensure the safety of nursery employees.

GGNRA Respirator Selection Guide

<u>Operation</u>	<u>Location</u>	<u>Control in Place</u>	<u>Hazardous Agent</u>	<u>Type of Respirator</u>
Pesticide application	Outdoors	Applicator with wand	Round up	N95 disposal or half-face with organic vapor cartridges & pre-filters.
Pesticide application and mixing	Indoors	Applicator with wand	Pesticides	Half-face with organic vapor cartridges & pre-filters or PAPR
Welding (low toxicity metals & galvanized)	Indoors and outdoors	Local ventilation	Iron fume, zinc oxide fume, ect.	N 100 half-face or disposable

Painting, brush application, solvent based low toxicity paints, epoxies & solvents.	Indoors	Natural ventilation	Toluene, xylene, ect.	Half-face with organic vapor cartridges.
Painting, brush or roller application, latex paints	Indoors and outdoors	Good natural ventilation		Not required
LE and EMT's	All	Distance	Tuberculosis	N 95 disposable
Fire fighting	All	Water	Smoke	SCBA
Woodworking, cutting, sanding hard woods.	Carpentry shop	Local exhaust ventilation	Wood dust	Half-face with N95 filters or N95 disposable.
Cleaning up mice droppings	Indoors and outdoors	Wet methods	Hantavirus	N 100 disposable
Cleaning up pigeon droppings	Indoors and outdoors	Wet methods	Crptococcosis, histoplasmosis and mycosis	N100 disposable or half-face with N100 filters.

Pesticide Usage

In the nurseries, our goal is to avoid use of petro-chemicals. We know these are pesticides. However, a pesticide is **ANY** substance used to kill a pest. Even organic compounds like Safer soap are pesticides if we use them to control a pest. Legally, these procedures apply to anything that would not be used in a home setting or in excess of home use amounts. Therefore, pesticides or hazardous materials include: ant bait, chlorine bleach, Lysol, and compost tea.

A pest can be an insect (including ants), fungus, virus, bacteria, weed, or rodent. Pesticides, including organically produced ones, are poisonous and must be used with caution. See Hazardous Materials Section for more information.

No GGNPC employee, intern or volunteer shall use a pesticide unless he/she is a certified pesticide applicator. Only Certified Applicators can apply any substance used to kill or control a pest. All Certified Applicators will mix, apply, clean-up and store substances in accordance with their training and California and Federal law. Further information regarding storage, use, container transport, container disposal and responsibility for each pesticide will be provided to the applicator during certification and subsequent trainings.

All employees, interns and volunteers who work around pesticides will be required to take the Worker's Safety Class, taught by authorized Park personnel each year.

Storage: Keep all pesticides in original containers only. If the container has a Danger or Warning signal word on the label store separately in a locked shed or area. Container lockers must be labeled and locked at all times. Keep all pesticides out of the reach of children, unauthorized personnel and pets. Key must be available only directly from the Nursery Manager and not stored in a common key locker. Do not store with foods or fertilizers. Post warning signs on pesticide storage areas.

The storage area must have a containment feature. In other words, trays with side to contain any leaks or spills from a bottle of pesticide. If you are not using a custom built Pesticide Storage locker with containment shelves, then each bottle or container must be stored in a tray with sides to contain any leaks.

Responsibilities: If a GGNPC employee or intern notices an unlocked storage container or a pesticide spill, he/she must report it immediately to the nursery manager. The spill should be confined immediately by using kitty litter, absorptive clay, or spill clean-up towels.

Golden Gate National Parks Conservancy Nurseries will not apply “restricted use” pesticides. For more information on pesticide application as well as other areas of nursery and field safety, workers can refer to the following six websites:

1. <http://www.cdpr.ca.gov/index.htm> (California Department of Pesticide Regulation)
2. <http://aapse.ext.vt.edu/> (American Association of Pesticide Safety Educators)
3. <http://www.anla.org/> (American Nursery and Landscape Association)
4. <http://www.alca.org/> (Associated Landscape Contractors of America)
5. <http://www.pgms.org/> (Professional Grounds Management Society)
6. <http://www.dir.ca.gov/> (Cal/OSHA)

Pesticide Safety Information

CALIFORNIA
DEPARTMENT OF
PESTICIDE REGULATION
1001 I Street,
Sacramento,
California 95814

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

N
No. 8

Safety Rules for Pesticide Handlers in Non-Agricultural Settings

This leaflet, the pesticide label, and your training, tell you about pesticide dangers at work. Your supervisor must know and help you learn about the pesticides you will use, how to safely use them, and how to protect yourself. Pesticides are chemicals that are used to kill insects, weeds, germs and plant diseases. Fertilizers are not pesticides.



Your employer must make plans for emergency medical care before you start working with pesticides. If you think that pesticides made you sick or hurt you at work, he must make sure that you are taken to the doctor right away. You do not have to pay for medical care if you get sick or hurt from pesticides at work.

Emergency medical care is available at

If urgent call **911**

For SF: CHW Health 415-972-2249

For Marin: Kentfield 415-485-3600

WHAT ARE MY RIGHTS?

You have the right to know the following about pesticides that have been used where you work

- when and where the pesticide was applied
- name of the pesticide
- the EPA registration number

When you are trained your supervisor must tell you where all this information is kept. You have the right to look at Material Safety Data Sheets (MSDS) and records for all pesticides used where you work. The MSDS tells you about the pesticide and its dangers.

If you think that pesticides have made you sick at work, your supervisor must make sure that you are taken to the doctor immediately.

EMPLOYERS: This is the hazard communication leaflet. Fill in the blank lines in this leaflet and display this handout at the employees' work site.

HS-1749
Revised September 2004

These records are kept at:

Safety information areas of each Nursery and the Nursery main Office, Presidio 1216.

If you get sick or hurt **BECAUSE OF YOUR JOB**, you have the right to file for worker's compensation. Workers' compensation will pay for your medical bills, and sometimes, lost pay.

Your supervisor must explain your rights to you. If you need more help in understanding your rights, call or go to your local county agricultural commissioner's office, local legal aid, and worker's rights office, union or the Department of Pesticide Regulation (DPR).

The DPR offices are:

- Anaheim (714) 279-7690
- Fresno (559) 243-8111
- Sacramento (916) 324-4100

WHO DO I TELL ABOUT DANGERS AT WORK?

Pesticides are only one kind of danger at your work. If you have a complaint about a pesticide safety problem you should call the county agricultural commissioner. Other health and safety complaints (bathrooms, drinking water, etc.) should be filed with the California Department of Industrial Relations-Cal/OSHA office. You can find the telephone numbers in the government pages of the telephone book.

What training should I get?

- You must be trained in a way that you understand **before** you begin working with pesticides, and anytime you work with new pesticides.

- You must also be given training each year to remind you how to work with pesticides safely.
- You must be told the ways a pesticide can hurt you and how to safely use each pesticide you work with. (Ask your supervisor for the N-1 safety leaflet to learn more about training.)
- You must get extra training if you have to use a respirator (ask your supervisor for the N-5 safety leaflet).



All the information in your training must also be written down. You will be given a paper to sign to show you have been trained. But only do that when you have finished the training and you understand what you heard.

WHAT CAN A PESTICIDE LABEL TELL ME?

Some of the most important things listed on the label are

- what chemicals are in the pesticide,
- first aid and health warnings,
- protective equipment you need,
- and directions for applying the pesticide.

All pesticides are poisonous. If a pesticide gets in or on you, it can hurt you or make you sick.

The pesticide label tells you how to safely mix and apply the pesticide. **The label must be at the place where you mix or apply the pesticide.** You must read and follow **ALL** directions on the label. There

may also be product bulletins or other extra label information that you must read and follow.

If you have to move pesticides from one place to another, or dispose of empty pesticide containers, there are special rules your supervisor must tell you about. Ask for the N-2 safety leaflet for more information.



How can I tell which pesticides are more dangerous?

Most pesticide labels have a signal word in large print on the front of the label. This word tells you about the acute health effect of the pesticide. If a pesticide can hurt you or make you sick right away, that's called an acute effect. If it takes months or years of exposure to a pesticide before you get sick, that's called a chronic effect.

- If the pesticide can make you very sick, the label will have a skull-and-crossbones symbol and the word **"POISON."**
- Words like **"FATAL"** or "may be fatal if swallowed, inhaled, or absorbed through the skin," mean the pesticide can make you very sick or even kill you.
- Some pesticide labels tell you about other health problems that might not show up until long after use, such as cancer (may take years) or dangers to unborn babies.



These are the words that tell about acute effects

DANGER means the pesticide is extremely harmful

WARNING means less harmful, but still dangerous

CAUTION means much slightly harmful, but still can make you sick

If the label does not have one of these words, it means that the pesticide is unlikely to harm you. However, **always** handle pesticides carefully.

WHAT ELSE DOES THE LABEL TELL ME?

- If the pesticide can severely hurt your eyes or skin, the label will say something like "Corrosive, causes eye and skin damage."

ARE THERE ANY EXTRA RULES FOR VERY DANGEROUS PESTICIDES?

Yes, there is a group of pesticides, called Minimal Exposure Pesticides (MEPs) that California has extra rules for because they could be especially dangerous to you.

These are the pesticides on this list

- Buctril
- Metasystox-R

See the N-10 safety leaflet or more information about these pesticides.

Other handouts mentioned in this document should be part of your training. They are free and are available from your supervisor and your local agricultural commissioner's office.

SUMMARY OF RECORDS YOUR EMPLOYER MUST KEEP

Information	Location
Training papers	Employer's office site
Written training program	Employer's office site
Respirator program procedures	Employer's office site
Accident response plan (fumigants)	Work site
Pesticide label	Work site
Pesticide Safety Information Series	Employer's office site
Material Safety Data Sheet	Employer's office site
Storage area posting ¹	Storage area
Emergency medical care notice	Work site
Doctor's report for respirator use	Employer's office site
Pesticide use records	Employer's office site

¹ Required only for pesticides with the Signal word "DANGER" or "WARNING"

SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT

In 1986, a law called the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) was passed. Proposition 65 requires California to make a list of chemicals that cause cancer, birth defects, or other reproductive harm. The Proposition 65 list contains many different chemicals, including dyes, solvents, pesticides, drugs, and food additives. If a pesticide is on the Proposition 65 list, your supervisor must warn you if you could be exposed to enough pesticide to result in a significant health risk. Your supervisor may also choose to warn you if a pesticide on the Proposition 65 list has been sprayed, even if health problems are not likely. Your employer is required to keep information on each pesticide application and allow you to look at it. If you are not sure of the record location, ask your supervisor.

If you don't get all the information you need in your training, or from your supervisor, you should call your County Agricultural Commissioner, or the Department of Pesticide Regulation (DPR) for more information. You can find the Commissioner's number in your local white pages phone directory.

DPR numbers are:

- Anaheim (714) 279-7690
- Fresno (559) 243-8111
- Sacramento (916) 324-4100

CURRENTLY REGISTERED PESTICIDES ON THE PROPOSITION 65 LIST

PESTICIDES KNOWN TO THE STATE TO CAUSE CANCER	
Arsenic acid	Folpet
Arsenic pentoxide	Formaldehyde (gas)
Arsenic trioxide	Iprodione
Cacodylic acid	Lindane
Captan	Mancozeb
Chlorothalonil	Maneb
Chromic acid	Metam Sodium
Creosote	Metiram
Daminozide	Oxadiazon
DDVP (dichlorvos)	Pentachlorophenol
Diuron	Propargite
p-Dichlorobenzene	Pronamide (propyzamide)
1,3-Dichloropropene	Propylene oxide
Dioctyl phthalate	Sodium dichromate
Ethylene oxide	Terrazole
Ethylene glycol monomethyl ether	Thiodicarb
Fenoxycarb	Vinclozolin

PESTICIDES KNOWN TO THE STATE TO CAUSE BIRTH DEFECTS OR REPRODUCTIVE HARM	
Amitraz	Methyl bromide (as a structural fumigant)
Arsenic pentoxide	Myclobutanil
Arsenic trioxide	Nitrapyrin
Bromoxynil octanoate	Oxadiazon
Chlorsulfuron	Oxydemeton-methyl
Diclofop methyl	Potassium dimethyldithiocarbamate
Disodium cyano-dithioimidocarbonate	Propargite
EPTC (ethyl dipropyl-thiocarbamate)	Resmethrin
Ethylene oxide	Sodium dimethyldithiocarbamate
Ethylene glycol monomethyl ether	Streptomycin sulfate
Fenoxaprop ethyl	Thiophanate methyl
Fluazifop butyl	Triadimefon
Fluvalinate	Tributyltin methacrylate
Hydramethylnon	Triforine
Linuron	Vinclozolin
Metam sodium	Warfarin
Metiram	

WHAT DOES 'RESTRICTED ENTRY INTERVAL' MEAN?

A restricted entry interval (REI) is the time after a pesticide is used that you are not allowed to go into the field. If you touch a plant during an REI, you might become sick. After a pesticide is used on a plant it begins to go away. This takes longer for some pesticides than for others

If you might go into or even near a sprayed field or greenhouse, the farmer or your foreman must tell you

- about the pesticide used
- what you must do to protect yourself
- how long to stay out of the field

Follow the directions about staying out of sprayed fields and greenhouses.

Can I ever go into a field that has an REI in effect?

Usually you must not go into a field until the REI is over. There are a few cases when you can. You may go into a field during the REI if you are doing a job where you will not touch anything that could have pesticides on it. For example, if you are driving a tractor.

There are a few other times when you can go into a field during an REI. However, you cannot go into the field until at least four hours after the pesticide application was finished. Then there are special rules that apply. Your foreman must know these rules and tell you about them before

you go into the field. He must also tell you how long you can work in that field in one day. For some kinds of jobs, you may only be allowed to work in that field for one hour.

WHAT DO I NEED TO KNOW IF I HAVE TO GO INTO A FIELD DURING THE REI?**Your foreman must tell you**

- the name of the pesticide sprayed and how long the REI is
- ways the pesticide can make you sick
- first aid
- how you may feel or look if you get pesticides in or on you
- what PPE you must wear
- how to keep from getting sick from being too hot
- how you may feel or look if you get sick from the heat, and first aid for this
- why you need to wash after you leave the field where pesticides have been used

Your employer must give you all the PPE you need to wear during the REI; and soap, water and towels to wash when you take off your PPE.

If you see a sign that looks like this, it means stay out of the field!



First Aid

HOW DO I GET READY FOR AN EMERGENCY?

If you have a pesticide label, know what the label says about first aid. If you work with pesticides, your supervisor must arrange ahead of time for medical care in case of an emergency. You should know the name of this clinic or hospital and where it is. If you don't know, ask your supervisor before an emergency happens. Never let sick or hurt people drive themselves to a doctor. They could have an accident on the road.

WHAT SHOULD I DO IF SOMEONE SWALLOWS A PESTICIDE?

•**Get help RIGHT AWAY.** If you have a phone, **call 911**, or the free phone number for the poison control center, 1-800-876-4766.

•If people are sleepy or unconscious from poisoning and you don't have a phone, **TAKE THEM TO A DOCTOR OR HOSPITAL RIGHT AWAY. DO NOT** give them anything to eat or drink. **DO NOT** try to make them throw up.

•If the person is awake and alert, follow the first aid instructions on the label. These directions will tell you what will be helpful or dangerous. For instance, making the person throw-up, or giving them milk or water to drink could be helpful or it might be dangerous, depending on the pesticide. Never use salt water or mustard to make people throw up. Some old labels may still recommend those things, but they are not safe.

WHAT SHOULD I DO IF I GET SICK FROM PESTICIDES?

•**Stop work RIGHT AWAY.** You must stop working with the pesticide. You must also stop any more pesticide from getting in your body. Read below to find out how to do this.

•**GET HELP.** Tell someone at your workplace what happened.

•Ask to be taken to a doctor or hospital

WHAT SHOULD I DO IF SOMEONE COLLAPSES WHILE THEY ARE USING PESTICIDES?

•First, get the person away from the pesticides, if you can do this without hurting yourself. Remember, the sick person might have pesticides on them that could get on you.

•Then get help **RIGHT AWAY.** If you have a phone, **call 911.**

•Try to stop pesticides from getting in the person's body. You can find out how later in this handout.

•If the person is not breathing and you know how, give CPR (cardiopulmonary resuscitation). The 911-rescue team will take the CPR over when they arrive.

REMEMBER: Tell the rescue workers about the pesticides. Also, remember that pesticides may not be the problem. It could, for instance, be a heart attack.

HOW CAN PESTICIDES GET INTO MY BODY?

There are four ways

- breathing dust, mist or vapor,
- getting on your skin
- getting in your eyes, *or*
- swallowing the pesticide.

To stop a person from breathing in pesticides

Take sick people where the air is clean. In open areas, go at least 100 feet away. If there is a wind, make sure it is blowing the pesticide away from you.

Pesticides on your skin

Most often, pesticides get in your body through your skin. Some pesticides move very fast through your skin. Others move slowly. Many pesticides can move through your clothes, even if they are waterproof. That is why it is important to get rid of any pesticide that gets on your skin or clothing right away.

To get pesticides off of your skin

- Take off all clothes that have pesticides on them.
- Shower with soap and clean under your nails.
- Wash your hair.
- If you don't have a shower or soap, use any clean water.
- Get dressed only in clean clothes. Do not put the clothes with pesticides on them back on. If you do, more pesticides can get into you body. (Be sure to wash any clothes that have pesticides on them separately and completely before wearing them again).

To get pesticides out of your eyes

- Rinse with plenty of water. Keep rinsing for at least 15minutes. Rinsing in a shower is okay, but **DO NOT** use a hard spray.
- Otherwise, pour water over your eyes or use a gentle flow from a faucet or hose.
- Blink while you are rinsing.
- DO NOT** force anybody's eyes open.

WHAT DO I NEED TO TELLTHE DOCTOR?

Be ready to tell the doctor or nurse exactly what happened. Warn the doctor or nurse that the person might be sick from pesticides. That way they can protect them-selves. Tell the doctor what you know about what happened with the pesticide to make the person sick. If you know, tell him the age of the sick people, and what pesticide was involved. Bring information about the pesticide to show the doctor. Copy the exact name of the pesticide from the label, and the active ingredient and EPA registration number. If you can't do this and have no other choice, bring the clean empty pesticide container (with the label still on it) or an unused, sealed container.

REMEMBER: People in the hospital can also get sick or hurt if a container with pesticides is dropped and broken.

Always tell your supervisor if someone gets sick or hurt at work. If you don't get all the information you need in your training, or from your supervisor, you should call your County Agricultural Commissioner, or the Department of Pesticide Regulation (DPR) for more information. You can find the Commissioner's number in your local white pages phone directory. DPR numbers are:

- Anaheim (714) 279-7690
- Fresno (559) 445-5401
- Sacramento (916) 324-4100

If an emergency **CALL911**, or the free phone number for the poison control center, 1-800-876-4766.

Fertilizer Usage

Before using any fertilizers, the GGNPC employee or intern should consult the MSDS. The person applying the fertilizer should then use all personal protective equipment (PPE) suggested by the MSDS. It is always a good idea to wear nitrite gloves when handling fertilizer.

EQUIPMENT AND TOOL SAFETY- Training Session Sheets in Appendix

Driver Safety

Motor vehicle accidents continue to be the leading cause of workplace death in the nation. In 1995 alone, 1,329 workers were killed on the job, in auto accidents. That's one employee death every 7 hours of every day.

Motor vehicle accidents are:*

- The leading cause of death at work.
- The leading cause of death for people age 15 to 24.
- The second most common cause of death for people age 25 to 44.
- The third most common cause of death for people age 45 to 64.
- The fifth most common cause of death for all ages behind heart disease, cancer, stroke, and lung disease.

*Source: 1995 statistics from the National Institute of Occupational Safety and Health (NIOSH) and the Bureau of Labor Statistics (BLS).

Fortunately, auto accidents are often preventable. By driving defensively and using good judgment, you can significantly reduce your chances of being hurt or killed in a motor vehicle. The following defensive driving tips are designed to help you avoid accidents and injuries from your fleet operations.

These rules are mandatory for all employees driving Conservancy and GSA vehicles.

- Personal and off duty use of Golden Gate National Parks Conservancy and Park Service vehicles is prohibited.
- Only authorized employees may drive NPS (GSA) or Golden Gate National Parks Conservancy vehicles. No other family members may drive company vehicles.
- Non-employee passengers are not permitted in Conservancy or GSA vehicles at any time unless they are business related.
- Seat belts must be worn in vehicles at all times.
- No employee is permitted to drive vehicles while impaired by alcohol, illegal or prescription drugs, or over the counter medications.
- All accidents involving Golden Gate National Parks Conservancy vehicles must be reported to the office immediately to Nan Haynes, 561-3001 or Betty Young, 561-4860. For Park Service vehicles, report to Nan who will help complete the report for the GGNRA Property Office 561-4718. Be sure to turn in accident report within 24 hours.
- Employees with two or more preventable accidents in a three year period, or that obtain three points on their driving record, will be subject to a loss of their driving privileges or have their driving privileges restricted.

- The single biggest thing you can do to save your life is wear your seat belt. Hundreds of studies over the years have proven, without a doubt, that seat belts save lives. This is true even in crashes involving fire and water submersion. Properly worn seat belts actually absorb crash forces that, otherwise, would be transferred to your body. If the seat belts in your vehicle are inoperative or defective, have them repaired or replaced immediately. You should wear the lap belt low across your hips and have the shoulder strap directly across your chest. You also need to keep the belt tight. There should not be more than an inch between your body and the belt at any point.
- Get the big picture while driving. Keep your eyes aimed high and try to anticipate hazards and other drivers' mistakes. You should be looking well ahead of where you are. You should also always leave yourself an out in case the other driver does the unexpected.
- Maintain a safe following distance at all times. Approximately 1/3 of all auto accidents are rear end collisions. You should be at least two seconds behind the vehicle in front of you to allow yourself sufficient time to stop. Do not tailgate. Following distances should be increased for larger vehicles or if in slippery or rainy conditions.
- Avoid passing on two lane roads. Head on collisions are the most common cause of fatalities. You should also turn on your headlights while driving on two lane roads. This helps oncoming traffic see and avoid you. Never pass another vehicle on blind turns or hills.
- You must be sober and alert at all times while driving. The use of drugs or alcohol while driving, or prior to driving, significantly increases your chances of having an accident. It should be at least eight hours from the time you take a drink until operating a vehicle. You should also avoid the use of prescription or over the counter medicines that make you drowsy.
- Inspect the vehicle for mechanical defects prior to each trip. Test your brakes as soon as you start out to insure they are properly operating. Worn tires can make your vehicle difficult to control or stop.
- Avoid dialing the phone, eating, reading maps or other distracting activities while driving. These actions take your eyes off the road and often cause you to swerve. Pull over into a safe parking area before making that call.
- Never drive faster than road conditions warrant. Slow down when road conditions are poor (rain, fog, night) and never exceed posted speed limits.
- Always signal when changing lanes or turning.
- Use caution when passing any stopped vehicle, especially near intersections or cross walks.
- Aggressive driving has become a significant problem in the past few years. Just don't do it. Avoid tailgating, rapid lane changes, speeding, and hand gestures to bad drivers. You

never know, they may be armed. If you are being tailgated, change lanes and let them pass. It's really not worth getting killed over.

- Intersection collisions are also a significant problem. These are often caused by someone running the red light. You should always be aware when approaching an intersection and be prepared to stop if the light changes.
- Slow down and look for trains at all railroad crossings. Even with modern signals and gates, hundreds of cars are hit by trains each year at grade crossings.
- Use your low beams while driving in fog and slow down. If you can't see, pull over into a safe parking area and wait for better visibility. Do not stop in the traffic lanes. You will almost certainly be hit by another vehicle if you do.
- Always walk behind the vehicle before backing. This will insure that there are no people or objects behind you that you cannot see from the driver's seat. You should also make sure that all loads are properly secured to prevent them from moving. Numerous accidents are caused by objects that have fallen off company vehicles.
- Always signal well in advance when changing lanes or turning, and make sure to check your blind spot for other vehicles. Also, avoid driving in someone else's blind spot. If they can't see you, they don't know you are there.
- Yield the right of way until you are sure the other driver is going to stop. Just because you have the legal right of way doesn't mean you should always take it. Always yield the right of way to emergency vehicles.

Defensive drivers:

- Expect the unexpected
- Anticipate bad driving by others
- Look ahead for hazards
- Always leave them an out
- Always drive under control
- Obey the rules of the road

What to do if an accident does occur:

- Report all accidents involving government vehicles or nursery vehicles to the fleet manager, Nan Hayes, 561-3001, as soon as possible. Park Police can also be called to the scene if the incident occurs within GGNRA.
- There are accident report Forms in each GSA (Federal) vehicle. These must be completed within 24 hours.

General Hand and Power Tool Safety

All nursery employees and volunteers should receive adequate training before using hand or power tools. At any time employees can also refer to Golden Gate Parks and Nursery Job Hazard Analyses documents to go step by step through safety procedures for a particular tool. Some good rules of thumb to following when using any hand or power tool include:

- Use the necessary PPE when using power tools, which may include safety glasses or goggles, earplugs, and leather or padded gloves.
- Before starting up any power tool, check the area you are working in and remove any hazards or obstacles.
- Keep all equipment well maintained and serviced. Sharp tools always work more efficiently and reduce stain and chance of injury.
- Power tools must be grounded or double insulated. All power tools are to be plugged into a grounded GFCI outlet.

- Do not use power tools in damp, wet or explosive atmospheres.
- Do not force hand power tools. Apply only enough pressure to keep the unit operating smoothly.
- Always have a cell phone or radio nearby to report emergencies.

Brushcutter

Only trained and certified employees or interns may use brushcutters.

Before using a brushcutter, please ensure the following:

1. That it is signed out to you and not reserved by anyone else.
2. Give the brushcutter a once over to ensure that it is in good working order:
 - Check that the blade is properly centered, sharp, and without cracks. Replace the blade if cracked.
 - check that the blade nut/weed whip is sufficiently tightened
 - check to make sure that the blade guard is free from cracks and/or defects, that it is the proper type for the cutting implement (weed whip vs. blade), and that it is properly secured
 - Check to make sure that the shaft and machine are free from cracks.
 - Check that all nuts and screws are sufficiently tightened on the power head
 - Start the brushcutter to ensure that it works prior to taking it out to the field. If available, consider taking a backup brushcutter in case the first machine breaks down in the field.
3. If using the blade attachment, ensure that there is not a high fire warning for the day of field work. Consult Fire Management Officer Alex Naar at 415-331-6374 the day prior to use.

Make sure to bring:

4. Appropriate safety gear for you and coworkers: ear, eye and face protection, chaps and harness, orange safety cones if working by a road or trail, etc.
5. Brushcutter box containing field tools and spare parts.
6. If you are using the blade:
 - someone else
 - fire extinguisher

7. Correct gasoline mixture. (2% oil, 98% gasoline = 2.6 fl. oz of oil per gallon of gasoline)
If you are not sure about the mixture of your gasoline, do not use it! Improper fuel mixtures will damage the engine.

After using the brushcutter:

8. Clean the exterior of the saw (bladeguard, blade, etc.)
9. Clean the air filter with a light soap solution and water. Rinse the soap out of the filter and then let the filter air dry. Install a clean dry filter in the brushcutter while the other is drying.
10. Replace weed whip line if cartridge is empty.
11. Drain gasoline from the engine if the machine will not be used in the coming days.
12. Record any mechanical problems or maintenance performed in the maintenance log. Tag broken machine with a description of problem. Report repair needs to Mike Perlmutter, 561-4859.

Quarterly maintenance:

- Maintain angle gear grease level at $\frac{3}{4}$ using special angle gear grease.
- Clean muffler.
- Clean exterior of spark plug.
- Clean cooling fins on the cylinder and check that the air intake at the starter is not clogged.
- Check the gapping on the spark plug (should be .5mm/.02")
- Check the coloration of the spark plug. Replace if necessary. Also, coloration and wear can indicate how the engine is running.

http://www.ngksparkplugs.com/techinfo/spark_plugs/faq/faqread2.asp

Brushcutter Box should contain:

Spare spark plug	Allen wrench
Spare pull chord	Spark plug gapper
Spare air filter	Rod
Spare locking bolt to secure blade	Repair tags and marker
Spare weed whip string	Rags
Scissors or blade to cut string	Rubber gloves
Scrench	

Propane Flamer Use

Only employees and interns trained and certified in Fire Extinguisher use and Flamer Use are permitted to use propane tanks and torches. Trainings provided by NPS, or contact Bruce Badzik, (415) 561-4831

Handsaw/Chainsaw

Tree cutting policy for nursery staff:

Extensive concerns due to infrastructure, trails with high visitor use or close to tree, make tree cutting in many areas of the park dangerous. Due to these concerns for the public, our volunteers, interns and staff, the following guidelines have been established:

- **No volunteer or intern** will be exposed to this danger by using a chainsaw.
- Nursery interns and other staff may take the NPS Wildland chainsaw training for their own professional development. However, an intern may not use a chainsaw outside of that class during their internship. Staff will be considered on a case-by-case basis, and only with additional supervised experience.
- Interns and staff who have attended handsaw training are allowed to cut saplings less than 10' tall (and generally less than 5" dbh) with a handsaw. Cutting can take place only in natural areas where removal has been approved.
- Even cutting saplings can be dangerous. Interns and staff will be offered a handsaw safety training each year. It will be taught by Peter Ehrlich, Presidio Trust Forester or one of the licensed arborists on his crew. They will cover safety procedures, personal protective equipment, visitor safety, plus proper cutting techniques.
- Climbing is inherently dangerous and requires extensive training. OSHA and ANSI require that an individual trained in aerial rescue must be on site when anyone is climbing. Merely the possession of tree climbing harnesses and ropes is **not** sufficient. No one (intern, staff or volunteer) may climb in a tree.
- The use of an orchard ladder requires training and this device or a pole saw can be used only after the individual has been adequately trained.



The main types of hand-saws used by **trained** nursery staff and interns are for light pruning which may include use of a bow saw, pull saw, or folding saw. Whenever using any type of hand saw for any size and height of tree you are required to wear the appropriate PPE which includes:

- A hard hat
- Safety goggles/glasses
- Gloves (leather preferred).

Other safety considerations to keep in mind when using any type of hand saw include:

- Insure that hands and legs are out of range of the saw. Body parts should never be underneath the direction of the saw or below the area being sawed.
- Maintain a wide stance with both feet planted firmly on the ground.
- Make sure your saw is sharp, dull blades can create a safety hazard.

Pruning shears and loppers

Pruning Techniques

- When removing branches use the 3-cut method to avoid ripping the bark of the tree and optimize the ability of the tree to heal the cut. The best pruning cuts are made just

outside the branch bark ridge or branch “collar,” parallel to the trunk of the tree. Make the nicest cleanest cuts possible. Proper pruning does not damage the branch bark ridge. Ask an expert to show you this very important anatomical characteristic of trees.

1. **Undercut**—Make the first cut about 1 to 2 feet from the main branch or trunk. Cut **upward** and go ¼ to 1/3 the total diameter of the branch.
 2. **Cut bulk of branch**—Make the second cut slightly beyond the first. Cut downward completely through the branch. This will reduce the weight of the branch and make your final cut easier and cleaner.
 3. **Final cut**—Make the final cut just beyond the branch bark ridge. The cut should be as small as possible and parallel to the branch collar.
- When removing branches to a new leader remove to a leader that is no less than 1/3 the size of the branch being removed. Also, be aware of the direction and angle of the new leader. See diagram below.
 - Only up to 25% of the entire canopy of the tree may be pruned during one pruning season, unless there are special circumstances.



Wheelbarrow

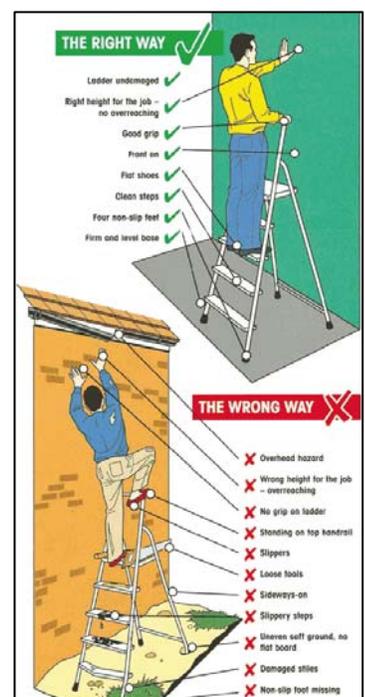
Following guidelines for field ergonomics will provide good standards of practice when using a wheelbarrow to transport heavy and large amounts of material. However, there are also more specific practices that should be exercised to ensure the proper and safe use of wheelbarrows.

- Always balance the load you are carrying in the wheelbarrow. Be sure you can see over and around the load to guide it safely and avoid running into things.
- When picking up a wheelbarrow, allow your legs to do most of the lifting to spare your back. Bend your legs instead of bending your back and never attempt to pick a load that is too heavy for you to lift safely.
- Always push the load forward.
- Cross over obstacles, such as planks or rails, at a right angle to prevent the load from tipping over.
- Inspect the wheelbarrow wheel regularly and make sure that is well maintained and completely inflated.
- Wear gloves.

Ladder

The primary hazard when using a ladder is falling, which can occur if you are using the ladder improperly or if the ladder is not well maintained. These basic guidelines will help prevent accidents and keep you safe when using ladders in the nursery or office:

- Inspect the ladder before using it. If it is broken, throw it out. Never repair a broken ladder, get a new one. Keep portable stairways, ladders and step stools in good condition and use them only in a safe manner.
- Use the proper ladder for the job. Do not use “A” frame ladders as straight ladders. Make sure the ladder is tall enough to reach the work area. Do not use metal ladders for electrical work.
- If a ladder must be used on an uneven surface, use only a three legged orchard ladder.
- Do not place ladders in passageways, doorways, or any location where they might be hit or jarred, unless protected by barricades



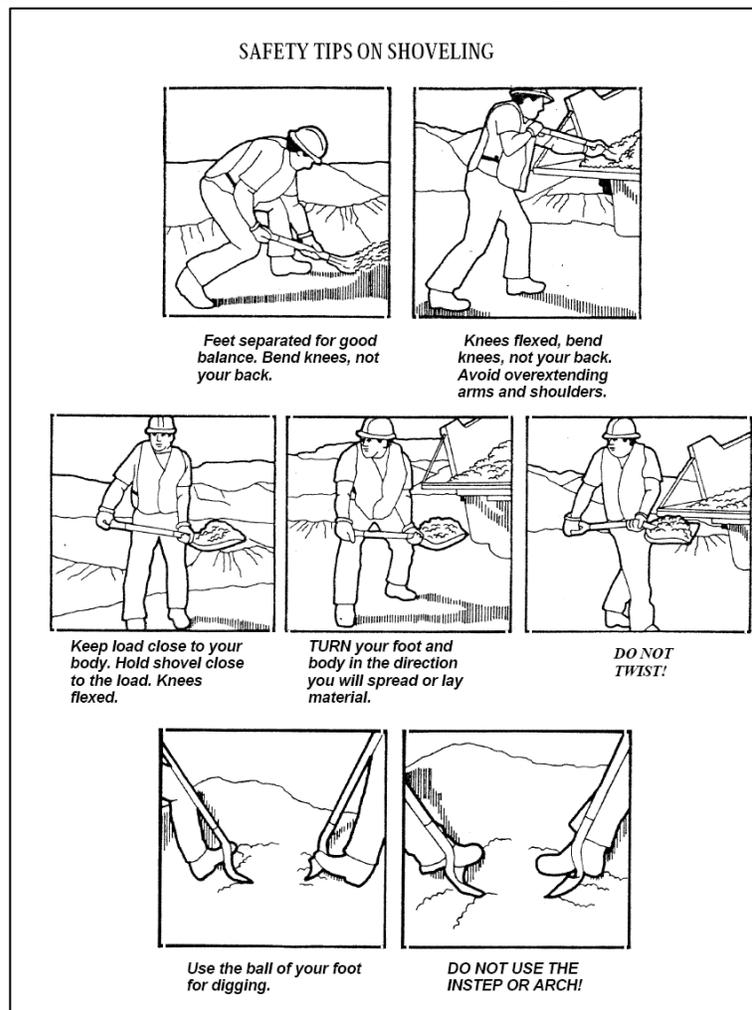
or guards.

- Ladders should only be placed on hard level surfaces. Make sure the ladder feet are not placed on sandy, slippery, or sloping surfaces. Clean or sweep the area where the ladder feet will be and make sure the rubber feet are in good shape.
- Ladder rungs and steps must be kept free of grease, oil, mud, or other slippery substances.
- Arrange your work so you are able to face the ladder and use both hands while climbing. Do not carry tools or equipment while climbing a ladder. Climb the ladder, and then hoist the tools or equipment with a line or a hoisting device.
- Avoid temporary ladders. Always use a commercially made, construction grade ladder of the proper length for the work being performed.
- Secure portable ladders in place and at a pitch so the leveling indicator is in alignment or the distance from the wall to the base of the ladder is at least 1' for every 4' of height.
- Straight ladders shall be tied off the top of the ladder to prevent slipping.
- Be aware of objects below you, move or cover sharp objects in case you fall. Cap or bend all rebar.
- Do not stand on or work from the 2nd rung from the top or above. Also do not reach too far from the ladder. Keep your belt buckle between the side rails.
- Extension ladders shall extend at least 36" above the level being accessed.
- On all ladders, do not step on cross bracing that is not intended to be used for climbing.

Shovels and Safe Techniques

Before you begin an activity that requires the use of the shovel be sure to check that the shovel you will be using is in good working order, for examples check that the handle is not splintering. Also make sure that you have the proper PPE, which includes gloves and sturdy work boots or shoes. Some tips for using a shovel safely include:

- Keep your feet separated for good balance and keep your knees flexed.
- Use the proper shovel for the task at hand: a short handled shovel can be used for spreading material while a long-handled shovel should be used for digging and carrying materials.
- Gradually increase the amount of material you are loading to make sure that you are not carrying or moving more than you can handle.
- Bend your knees but not your back when shoveling.
- Keep your arms and elbow close to your body when moving materials.
- **Never** twist your body when lying out or spreading material, instead turn your foot



- and body in the direction you intend to spread or lay out the material.
- For digging, use the ball of your foot (not the arch) to press the shovel into the dirt.

Electrical Safety

As nursery employees, we will have limited exposure to electrical maintenance; however, we do use electric power tools and other equipment plugged into electrical circuits. For this reason we should all keep these basic safety rules in mind when using any type of electrical device:

1. Do not attempt to operate any switch, valve, or other energy-isolating device bearing a lock.
2. Safety grounds shall always be used where there is a danger of shock from back feeding or other hazards.
3. Polyester clothing or other flammable types of clothing shall not be worn near electrical circuits.
4. All power tools will be grounded or double insulated. Tools with defective cords or wiring shall not be used.
5. Metal jewelry should not be worn around energized circuits.
6. Extension and temporary power cords must be heavy duty and grounded (three pronged plugs into a three hole outlet). Frayed or defective cords shall not be used.
7. Suitable temporary barriers or barricades shall be installed when access to opened enclosures containing exposed energized equipment is not under the control of an authorized person.
8. Electrical installations must be protected from accidental contact by enclosures or tight fitting covers.
9. Ground Fault Circuit Interrupters (GFCI's) are required on all power outlets.
10. Circuits shall not be overloaded with equipment or extension cords.
11. Metal measuring tapes, fish tapes, ropes or other metal devices are prohibited where they may contact energized parts of equipment or circuits.

Tagout

All broken or improperly functioning electrical equipment shall be tagged prior to repair, cleaning, or adjustment. No repairs will be performed by Conservancy staff, interns or volunteers.

Power Tool Safety

The below power tools may not be regularly used at the Nurseries, however, there may be projects that warrant the use of power tools for construction. There is also a full woodshop located in the Presidio Nursery main building. Before using any Nursery power-tool equipment

make sure that you have been properly trained and have signed a training sheet for each tool you may be using.

Grinder

- Always use grinder on a cement floor with plenty of free/open space.
- Always use **safety glasses** when using the grinder to protect the eyes from airborne sparks and metal bits.
- Always use **earphones or earplugs** to protect your hearing while using the grinder.
- Position the grinder away from anything flammable, i.e. wood, cardboard, gas, etc. Sparks can and do fly!
- Always have a bucket of water next to the grinder – to cool tools and for emergency fires.
- If possible, sit on a stool, this helps to steady tools when sharpening them.

Power Hand Drill

- Wear the proper PPE: eye and hearing protection.
- Keep drill vents clear to maintain adequate drill ventilation.
- Keep drill bits sharp.
- Keep electric cords clear of drilling area.
- Secure the material to be drilled.
- Slow the rate of feeding before breaking through the surface you are drilling into.
- Drill a small pilot hole before drilling large holes.
- Unplug the drill before changing drill bit or other attachments.
- Remove the chuck key before plugging in the drill.
- Do not use bent drill bits.
- Make sure you are in a stable position before drilling. Do not overreach while drilling.
- Do not drill with one hand while holding the material with the other hand.

Table Saw

- Wear the proper PPE: eye protection, hearing protection, and in some cases respiratory protection.
- Make sure the anti-kickback and blade guard is in place and working correctly.
- Choose the proper saw blade for the type of work you are doing.
- Keep saw blades clean, sharpened, and properly set so that they will cut without being forced.
- Feed material in the saw blade counter to the direction of rotation.
- During cutting, keep hands out of the line of the saw cut.
- Never perform free-hand sawing. Make sure what you are cutting is held firmly against the mitre gauge or rip fence and guide the cut.
- Do not reach around or over a moving saw blade.
- Do not leave the table saw unattended while the saw blade is in motion.

Chop Saw

- Wear the appropriate PPE: protective safety glasses and a face shield.
- Do not wear gloves, loose fitting clothing, jewelry, or any dangling objects that could become caught in the rotating parts of the saw.
- All guards should be in place and in good working order.
- Keep hands and fingers clear of the path in which the blade travels.

- Use only the recommended RPM and sizes of blades for the material you are cutting.
- Before making changes to the chop saw, make sure it is unplugged and that the blade is correctly positioned and secured on the saw's arbor.
- Clamp down the material you are cutting and never perform freehand cutting.
- Never re-cut small pieces.
- After completing a cut, release the trigger and allow the blade to come to a complete stop before raising the blade from the workplace.

Drill Press

- Wear the appropriate PPE: eye protection. DO NOT wear: loose clothing, which can get caught in the drill or gloves, watches, and bracelets'. Tie up long hair
- Make sure you are in close proximity with the on/off switch.
- Use a clamp or drill vise to hold the material you are drilling in place.
- Make sure the drill bits you are using are clean and sharp.
- Make sure all guards are in place and in working order.
- Do not make adjustments to the drill press until it has completely stopped. Make sure to remove chuck key before turning the drill back on.
- Do not use your hands to hold material you are drilling holes larger than ½ inch. Never put your hand under the material you are drilling.
- Do not leave a drill press running unattended.

Trenching and Excavation

If a contractor is trenching at your nursery site, be sure that they are in compliance with the following GGNPC guidelines:

- All excavations and trenches 5 feet deep or greater must be shored, sloped, or benched to protect workers from the hazards of moving earth. All trenching must be done in accordance with Cal/OSHA regulations. No Golden Gate National Parks Conservancy employee, interns or volunteer may participate in excavation or trenching greater than 2 feet.
- Always locate underground utilities before digging. Also contact regional notification centers in advance.
- Do not work under loads handled by lifting or digging equipment.
- Keep all spoils 2' from the edge.
- Barricade trenches or use caution tape to warn others of their presence.
- Inspect all trenches and excavations daily, before work, to look for signs of shifting earth.
- Do not jump over trenches, use wood planks or sheeting.

HAZARDS IN THE FIELD

Poison Oak

Recognition

Poison oak (*Toxicodendron diversilobum*) is most notoriously identified by the three leaf rule, “leaves of three let them be.” Although this rule is good to follow, it is important to note that poison oak can be found in many different growth forms, occurring as a vine, shrub, or as low lying ground cover and can exhibit different leaf size morphology. In general, leaves are glossy, dark green, and deeply lobed; however, the poison oak plant is deciduous and leaves change color in the summer months to bright red, pinkish and orange and fall off completely by early winter.



Precautions

Avoid contact if possible, if avoidance is not possible then protect skin (particularly sensitive areas) by wearing a Tyvek suit (or other oil resistant coveralls) and apply a protective soap prior to exposure (such as Tecnu or Ivy Block). Taking such precautions will reduce the likelihood of exposure to and/or skin penetration of the oily sap of the plant called *urioshol* that causes allergic reaction. All parts of the poison oak plant contain urioshol oil so it is possible to become exposed to the plant even after all the leaves have fallen.

Decontamination

If exposed to poison oak, wash the infected area with soap and water as soon as possible, waiting more than two hours to treat the exposed area increases the likelihood of infection. Using soap (or Tecnu), wash the skin for two minutes using cold water. Be aware of contamination of clothing and tools; wash these items after exposure as well. If infection does occur, allergic rashes may appear in one day or take three days and can continue to appear for as long as a week after exposure. Less severe allergic reactions can be treated with antihistamine and anti-itching medications; however, more severe infections or infections occur very close to the eyes should be examined by a doctor.

Hantavirus

Hantavirus is a rare but frequently fatal rodent-borne virus. Only one rodent in California is known to carry the disease, the deer mouse (*Peromyscus maniculatus*), which is a highly abundant rodent found in all habitat types and is distinguishable by its size (4 to 7 inches), color (grey to brown with white fur on its belly), and large ears. Infected deer mice will not exhibit signs of illness, making it difficult to distinguish between infected and non-infected rodents. For this reason, all rodents should be treated as potentially infectious and all preventative measures should be taken.

Controlling mice in the nurseries

Follow these basic precautions to prevent mice infestation in your nursery or office space:

- Keep food in sealed containers or in the refrigerator.
- Clean up spilled food immediately and use garbage containers with tight fitting lids.
- Keep counters and tables free of food debris.
- Use weather-stripping or brushes on doors.

Rodent proofing your nursery may also help prevent infestation, some helpful practices may include:

- Cover or fill holes in the exterior of nursery buildings; caulking works well to fill holes.
- Move woodpiles, food compost, and trash cans away from nursery buildings or elevate off the ground.

Safety precautions for cleanup

Transmission of the virus occurs primarily by inhalation of aerosols contaminated with virus from rodent secretions. For this reason it is very important to minimize the amount of stirring up of materials into the air when cleaning. Some precautions that should be used when cleaning areas suspected of contamination by rodents include:

- Ventilation of the affected area the night before cleaning.
- Use rubber gloves.
- Apply disinfectant spray at maximum recommendations to dead rodents, rodent droppings, nests, and surrounding areas and allow 15 minutes to pass before removing.
- Wear a respirator (become certified first).
- Use a wet mop for cleanup, never sweep up droppings.
- Lysol or chlorine bleach at a 1:10 dilution are good disinfectants.

Symptoms

Early symptoms of Hantavirus are similar to the common flu and may include fever, headache, muscle aches, vomiting, and abdominal pain. These symptoms may last a few hours to several days. As the illness progresses, the lungs fill up with fluid, making breathing difficult. If have been exposed to rodents or their secretions and develop flu-like symptoms 1-6 weeks after exposure, contact your doctor immediately. There is no specific treatment for the virus other than early diagnosis and treatment of symptoms.

West Nile Virus

West Nile virus is an arbovirus (arthropodborne virus) transmitted by blood feeding insects such as mosquitoes that causes encephalitis or inflammation of the brain. Primarily, West Nile is transmitted to animals or humans from an infected bird via an insect carrier and cannot be transmitted directed from animal to person, person to animal, or person to person.

Prevention

The best form of prevention from contracting West Niles virus is to limited exposure to mosquitoes. As nursery employees, we are often required to work in the outdoors and have a higher risk of coming into contact with mosquitoes. In general, you can reduce your risk of being bitten by:

- Avoiding working during dawn and dusk when mosquitoes are most active.
- If necessary to work for extended periods during these times of day you can prevent being bitten by: wearing long-sleeved shirts, long pants, a hat, and gloves and use an insect repellent on clothes or sparingly on exposed skin.
- Use a repellent with 20-30% DEET as the active ingredient.
- A head net and net coat can be used as a form of protection on warm days.
- Also, to prevent mosquitoes from being attracted to nursery buildings avoid keeping buckets of standing water in and near the nursery.

Diagnosis and Treatment

Symptoms of West Nile virus may vary from no symptoms at all to mild symptoms including fever, headache, and body aches, often with skin rash and swollen lymph glands. Severe infections may include headache with high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and rarely, death. Blood tests can confirm infection of West Nile; if you experience some or all of the listed symptoms and have been recently bitten by a mosquito(s), you should see your primary care physician to be tested for the virus. Treatment for the virus is often not specific and may vary depending upon your symptoms and complications as they develop.

Ticks and Tick Bourne Diseases Including Lyme Disease

Lyme disease is caused by a bacteria transmitted to people through ticks bites. It is best to avoid working in areas with high risk of tick infestation, particularly during the spring and summer months when nymphal ticks feed. However, as nursery employees, it is often necessary to work in the field and in areas with high risk of tick exposure. Because of this, it is important to understand preventative measures as well as the best practices to recognize and remove ticks.

Preventative Strategies

If working in potential tick infested areas, wear light colored clothing so that ticks can be easily spotted. Wear long sleeved shirts and tuck pant bottoms into socks or boots to help keep ticks from coming into contact with your skin. Ticks are often located close to the ground, so wearing boots may provide additional protection. Insect repellants containing DEET can also be used at employee's discretion.

Tick Check and Removal

Transmission of the Lyme disease bacteria can occur before 36 hours of tick attachment, for this reason it is good practice to check for ticks immediately after working in high risk area. Have someone help you look for ticks, as they can easily be attached in hard to see areas. Ticks tend to settle in warm areas of the body including the thigh, groin, or armpits.

If you find a tick, the best practice for removal is to use tweezers to grasp the tick as near to the skin surface as possible. Do not try and burn or crush the tick, or try to smother the tick with ammonium or petroleum jelly. Instead, try and remove the entire tick, including mouth parts, and then clean the area with an antiseptic. It is not necessary to take preventative antibiotics after removing the tick, but do be aware of symptoms of Lyme disease in the following weeks.

Sun Exposure

As a nursery staff member or intern, you will likely spend extended periods working in the outdoors and thus will greatly increase your risk to hazards from sun exposure. For this reason, it is important to always keep in mind what these hazards are and how to best protect yourself from these hazards, which may include sunburn, increased risk to skin cancer, and heat exhaustion.

Ways to protect yourself from sunburn and skin cancer

- **Generously apply sunscreen!** and reapply throughout the day.
- Wear a hat to protect your face and neck
- Wear a long sleeved shirt made from light material.

Tips for correct use of sunscreen

- For maximum effectiveness, apply a sunscreen that blocks both UVB and UVA light 20 to 30 minutes before your start working outside.
- Use a generous amount and use a sunscreen product with a sun protection factor (SPF) of 15 or higher.
- For best results, reapply every two hours and immediately after intense sweating.

Ways to protect yourself from heat exhaustion

Heat exhaustion or heat stress occurs when your normal body temperature becomes elevated and your body loses the ability to respond to transfer heat out of your body to keep you cool (by sweating and increasing blood flow to the skin). Heat related illness can occur when you are working and exercising for long hours in the field and are often caused or made worse by dehydration and fatigue. Some ways to prevent heat illnesses include:

- On particularly hot days, designate field sites in the shade whenever possible.
- Bring plenty of water to your work site and be sure to hydrate every hour.
- Wear appropriate clothing that will protect you from the sun.
- Be aware of medications that may increase your risk and the risk of volunteers to heat-related illnesses.

Some signs of heat illness include:

- Heat rash (prickly heat), which occurs when the sweat ducts to the skin become blocked, swells, and cause discomfort and itching.
- Heat cramps, which occur in muscles after exercise because sweating causes the body to lose water and salt and minerals (electrolytes).
- Heat edema (swelling) in the legs and hands, which can occur when you sit or stand for a long time in a hot environment.
- Heat tetany (hyperventilation and heat stress), which is usually caused by short periods of stress in a hot environment.
- Heat syncope (fainting), which occurs from low blood pressure when heat causes the blood vessels to expand (dilate) and body fluids move into the legs because of gravity.
- Heat exhaustion (heat prostration), which generally develops when a person is working or exercising in hot weather and does not drink enough liquids to replace those lost fluids.
- Heatstroke (sunstroke), which occurs when the body fails to regulate its own temperature and body temperature continues to rise, often to 105° (40.6°) or higher.

If you or a person you are working with exhibits signs of heat-related illness contact your supervisor or park dispatch, 561-5505. Heat stroke is a **very serious** condition and can be life-threatening, it is important to seek immediate treatment for this illness.

Working around yellowjackets

It is common to come across yellow jackets in the field, especially in more urban areas of the park. Yellow jackets commonly take over abandoned rodent holes and build nests underground, although they do build aerial nests. They will defend their nests vigorously when disturbed. Our native yellow jackets nest in the ground, making their hives extremely hard to detect and easy to step on. However, if you keep a watchful eye, the native hives can be spotted by observing a steady stream of yellow jackets flying in and out of an area. This area could be on the bare ground, making it relatively easy to see, or it may be in a bramble of blackberry, in a shrub, or in

NURSERY Safety Manual.doc

ice plant, making it not so easy to detect. Some things to keep in mind when working out in the field or in a nursery nearby a hive include:

- Defensive behavior begins in the spring and increases as food becomes scarce in the fall. For this reason, it is a good idea to scope out field sites and around the nursery for hives and avoid working in these areas during these times of year.
- Yellow jackets will usually only attack when they perceive something as a threat to their nest.
- Yellow jackets can sting repeatedly unlike bees; therefore it is best to run away from the area as quickly as possible. Zigzag patterns make it difficult for them to follow you but do not swat at them, as yellow jackets react aggressive to fast movements.

Allergies to yellow jacket stings

It is hard to know if you are allergic to yellow jackets unless you have been stung before, furthermore, how allergic you are to stings can be difficult to determine because venom can build up in your bloodstream over a lifetime, causing your reaction to increase each time you are stung. Most non-allergic people experience piercing pain at the site of the bite for about five minutes; others may experience a more severe reaction that may include varying degrees of swelling around the bite and pain at the site for up to a few days.

Nursery Safety Manual Policy Receipt

This is to certify that I have read the Golden Gate National Parks Conservancy Nursery manual. I have read these instructions, understand them, and will comply with them while at my workplace and while driving company vehicles.

I understand that failure to abide by these rules will result in disciplinary action and possible suspension of my driving privileges. I am aware that if my actions violate these rules and threaten the safety of others, my position with the GGNPC Nurseries will be terminated.

I also understand that I am to report any accident or unsafe issues in the workplace to my supervisor immediately.

Print Name

Sign Name

Date

Copy: Employee
 File at Nursery
 File in Nursery Program Director's office
 File in Nan Haynes, main office manager's office.



OCCUPATIONAL HEALTH MEDICAL CLINICS

San Francisco County

CHW Health Center

Pacific Bell Park

24 Willie Mays Plaza

San Francisco, CA 94107

(415) 972-2249

Hours: M – F 7:30am – 5:30pm

Franciscan Treatment Room

1199 Bush Street, Suite 160

San Francisco, CA 94109

(415) 353-6305

Hours: M – F 7:30am – 5:00pm

Marin County

Kentfield Occupational Medicine

1125 Sir Francis Drake Blvd.

Kentfield, CA 94904

(415) 485-3600

Hours: M – F 8:00am – 5:00pm

Saturday and Sunday Only

1. Seek medical attention at your own medical facility

Or

2. Seek medical attention at the nearest facility

MANAGER'S INJURY & ILLNESS REPORT GOLDEN GATE NATIONAL PARKS CONSERVANCY			
<i>INSTRUCTIONS: Complete this form and send it to the HR department when an employee is injured on the job.</i>			
Name of Employee			Today's Date
Department of Employee		Location of this incident	
Date of incident:	<i>Time of incident:</i>	Date you knew about this:	Date you notified HR:
List as much as you know about how this incident occurred. Was anyone else involved? Who? Were there any witnesses? Who?			
Name(s) of Witness(es) If you were not a direct witness to this incident, how were you informed about it? Who told you?			
Did the employee need or seek medical attention?			
If YES, where? When?			
Did the employee miss any time from work due to this incident? If yes, please list all dates and hours missed.			
Has any other employee experienced a similar incident, doing the same task or something related? Explain.			
What Actions Have Or Will Be Taken To Prevent This From Happening Again? - Do you recommend any?			
Your name and Title:		Date:	Reviewed By (HR):
			Date:

Emergency Contact Numbers

Park Dispatch, Emergency.....	911
Park Dispatch, Emergency (Cell Phone).....	(415) 561-5505
Park Dispatch, Non-Emergency.....	(415) 561-5510

Outside of GGNRA

Marin Sheriff's Office, Emergency.....	(415) 472-0911
Marin Sheriff's Office, Non-Emergency.....	(415) 332-5422
San Francisco Office of Emergency Services.....	(415) 499-2700 /2701
San Mateo Office of Emergency Services.....	(415) 363-4790
U.S. Coast Guard (Marine Safety Officer).....	(415) 399-3547
Poison Information.....	1-800-8poison (876-4766)

Presidio Contact Numbers

Presidio Trust Duty Officer.....	(415) 850-6092 /6043
Presidio Trust Remediation Manager (Craig Cooper).....	(415) 561-4259
Presidio Trust Archeologist (Eric Blind).....	(415) 561-5091
Presidio Trust Operations Manager (Steven Potts).....	(415) 561-5330
Presidio Trust Public Affairs (Tia Lombardi).....	(415) 561-7615

GGNRA Contact Numbers

GGNRA Remediation/Contamination Manager (Brian Ullensyang).....	(415) 561-4439
GGNRA Remediation Alternate/Haz materials (Tony Di Stefano).....	(415) 561-4143
GGNRA Safety Officer (Rob Gruhot).....	(415) 561-4974
GGNRA Archeologist (Leo Barker).....	(415) 561-4836
GGNRA Public Affairs (Chris Powell).....	(415) 561-4732

GGNP Conservancy Contact Numbers

Vehicle Accidents or Needs (Nan Haynes).....	(415) 561-3001
Ergonomics (Holly Chrobak).....	(415) 561-3061
Public Affairs (David Shaw).....	(415) 561-3064
Webmaster (Mark Pothier).....	(415) 561-3019
Accounts Payable.....	(415) 561-3008
GIS (Michael Norelli).....	(415) 561-3091
Computer Help.....	(415) 561-3099
Human Resource Emergency.....	(415) 561-3005
Betty Young (Nursery Program Director).....	(415) 561-4860
	Cell Number: (415) 497-5671

Monthly Safety Checklist**Periodic Safety Inspections of the nurseries,
by assigned staff or manager**

Day each month to be done _____

Date of this inspection _____

Employee Education:

- New employee training completed
- Training completed for employees with change of duties or new equipment
- Ongoing education being done

Walking/working surfaces

- Trip and fall hazards removed
- Walkways free of algae and not slippery
- Ramps in good condition
- Ladders in good condition
- Working areas, driveways, and parking areas free of debris

Exits

- sufficient exits available
- Exits accessible and free from obstructions
- Exits plainly marked
- Exit lights working, if available
- Alarms working, if available

Fire Protection

- Extinguishers- adequate number and type, fully charged, locator signs in place
- Fire Alarm system - batteries tested

Personal Protective Equipment

- Eye protection available
- Respiratory protection available
- Gloves available
- Goggles available
- Special PPE for equipment available

First Aid

- First Aid kits well stocked
- All VIP mgrs have up to date First aid training
- Eye wash bottle solution not out of date
- Emergency medical procedures understood by all

Vehicle Operation

- Vehicles Maintained
- Vehicle checklist done today

Electrical

- Two wire extension cords eliminated
- Surge protectors used
- No cords under mats, across walkways or near wet areas
- Ground fault circuit Interrupters (GFCI) used in wet areas

- Smoke alarm- batteries tested
 - Automatic sprinklers in good condition
- General Conditions**
- toilets clean
 - Food prep area clean
 - eating areas clean
 - Ventilation adequate
 - Adequate lighting provided
- Hazardous Materials and Operations**
- Flammable liquids stored properly, closed cabinet with liquid containment, locked, labeled.
 - Flammable sprays handled and stored properly
 - Pesticides stored properly
 - All materials stored as recommended on MSDS
 - Corrosives stored separately in own cabinet
 - Propane stored outside in locked open cabinet
 - No acids with caustics, Oxidizers stored separately
 - MSDS obtained for any new product
- Outlets, switches and boxes covered with plastic switch plates
 - Hazardous electrical equipment stored properly
- Machine Guarding**
- Woodworking machines guarded
 - Abrasive wheels and grinders have guards
 - Table saws guarded
 - Other machinery inspected
- Material Handling and Storage**
- Storage areas well organized and free from hazards
 - Stacking and piling at minimum
 - No heavy objects above breast height
- Hand and Power Tools**
- Hand tools in good condition - handles in tact, no cracks
 - Portable power tools - no frayed cords, switch works, guards in place

Insert Copy of your Nursery Emergency Meeting Place Map HERE.

<u>Brushcutter Safety</u>	
Date of Training	
Trainer name	

Brushcutter

Only trained and certified employees or interns may use brushcutters.

Before using a brushcutter, please ensure the following:

- That it is signed out to you and not reserved by anyone else.
- Give the brushcutter a once over to ensure that it is in good working order:
 - Check that the blade is properly centered, sharp, and without cracks. Replace the blade if cracked.
 - Check that the blade nut/weed whip is sufficiently tightened.
 - check to make sure that the blade guard is free from cracks and/or defects, that it is the proper type for the cutting implement (weed whip vs. blade), and that it is properly secured.
 - Check to make sure that the shaft and machine are free from cracks.
 - Check that all nuts and screws are sufficiently tightened on the power head.
 - Start the brushcutter to ensure that it works prior to taking it out to the field. If available, consider taking a backup brushcutter in case the first machine breaks down in the field.
- If using the blade attachment, ensure that there is not a high fire warning for the day of field work. Consult Fire Management Officer Alex Naar at 415-331-6374 the day prior to use.

Make sure to bring:

- Appropriate safety gear for you and coworkers: ear, eye and face protection, chaps and harness, orange safety cones if working by a road or trail, etc.
- Brushcutter box containing field tools and spare parts.
- If you are using the blade:
 - someone else
 - fire extinguisher
- Correct gasoline mixture. (2% oil, 98% gasoline = 2.6 fl. oz of oil per gallon of gasoline)

If you are not sure about the mixture of your gasoline, do not use it! Improper fuel mixtures will damage the engine.

After using the brushcutter:

- Clean the exterior of the saw (bladeguard, blade, etc.)
- Clean the air filter with a light soap solution and water. Rinse the soap out of the filter and then let the filter air dry. Install a clean dry filter in the brushcutter while the other is drying.
- Replace weed whip line if cartridge is empty.
- Drain gasoline from the engine if the machine will not be used in the coming days.
- Record any mechanical problems or maintenance performed in the maintenance log. Tag broken machine with a description of problem. Report repair needs to Mike Perlmutter, 561-4859.

Quarterly maintenance:

- Maintain angle gear grease level at $\frac{3}{4}$ using special angle gear grease.

<u>Handsaw/Chainsaw</u>	
Date of Training	
Trainer name	

Handsaw/Chainsaw

Tree cutting policy for nursery staff:

Extensive concerns due to infrastructure, trails with high visitor use or close to tree, make tree cutting in many areas of the park dangerous. Due to these concerns for the public, our volunteers, interns and staff, the following guidelines have been established:

- **No volunteer or intern** will be exposed to this danger by using a chainsaw.
- Nursery interns and other staff may take the NPS Wildland chainsaw training for their own professional development. However, an intern may not use a chainsaw outside of that class during their internship. Staff will be considered on a case-by-case basis, and only with additional supervised experience.
- Interns and staff who have attended handsaw training are allowed to cut saplings under 10' tall (and generally less than 5" dbh) with a handsaw. Cutting can take place only in natural areas where removal has been approved.
- Even cutting saplings can be dangerous. Interns and staff will be offered a handsaw safety training each year. It will be taught by Peter Ehrlich, Presidio Trust Forester or one of the licensed arborists on his crew. They will cover safety procedures, personal protective equipment, visitor safety, plus proper cutting techniques.
- Climbing is inherently dangerous and requires extensive training. OSHA and ANSI require that an individual trained in aerial rescue must be on site when anyone is climbing. Merely the possession of tree climbing harnesses and ropes is **not** sufficient. No one (intern, staff or volunteer) may climb in a tree.
- The use of an orchard ladder requires training and this device or a pole saw can be used only after the individual has been adequately trained.

The main types of hand-saws used by **trained** nursery staff and interns are for light pruning which may include use of a bow saw, pull saw, or folding saw. Whenever using any type of hand saw for any size and height of tree you are required to wear the appropriate PPE which includes:

- A hard hat
- Safety goggles/glasses
- Gloves (leather preferred).

Other safety considerations to keep in mind when using any type of hand saw include:



<u>Driver Safety</u>	
Date of Training	
Trainer name	

Driver Safety

Motor vehicle accidents continue to be the leading cause of workplace death in the nation. In 1995 alone, 1,329 workers were killed on the job, in auto accidents. That's one employee death every 7 hours of every day.

Motor vehicle accidents are:*

- The leading cause of death at work.
- The leading cause of death for people age 15 to 24.
- The second most common cause of death for people age 25 to 44.
- The third most common cause of death for people age 45 to 64.
- The fifth most common cause of death for all ages behind heart disease, cancer, stroke, and lung disease.

*Source: 1995 statistics from the National Institute of Occupational Safety and Health (NIOSH) and the Bureau of Labor Statistics (BLS).

Fortunately, auto accidents are often preventable. By driving defensively and using good judgment, you can significantly reduce your chances of being hurt or killed in a motor vehicle. The following defensive driving tips are designed to help you avoid accidents and injuries from your fleet operations.

These rules are mandatory for all employees driving Conservancy and GSA vehicles.

- Personal and off duty use of Golden Gate National Parks Conservancy and Park Service vehicles is prohibited.
- Only authorized employees may drive NPS (GSA) or Golden Gate National Parks Conservancy vehicles. No other family members may drive company vehicles.
- Non-employee passengers are not permitted in Conservancy or GSA vehicles at any time unless they are business related.
- Seat belts must be worn in vehicles at all times.
- No employee is permitted to drive vehicles while impaired by alcohol, illegal or prescription drugs, or over the counter medications.
- All accidents involving Golden Gate National Parks Conservancy vehicles must be reported to the office immediately to Nan Haynes, 561-3001 or Betty Young, 561-4860. For Park Service vehicles, report to Nan who will help complete the report for the GGNRA Property Office 561-4718. Be sure to turn in accident report within 24 hours.

- Employees with two or more preventable accidents in a three year period, or that obtain three points on their driving record, will be subject to a loss of their driving privileges or have their driving privileges restricted.
- The single biggest thing you can do to save your life is wear your seat belt. Hundreds of studies over the years have proven, without a doubt, that seat belts save lives. This is true even in crashes involving fire and water submersion. Properly worn seat belts actually absorb crash forces that, otherwise, would be transferred to your body. If the seat belts in your vehicle are inoperative or defective, have them repaired or replaced immediately. You should wear the lap belt low across your hips and have the shoulder strap directly across your chest. You also need to keep the belt tight. There should not be more than an inch between your body and the belt at any point.
- Get the big picture while driving. Keep your eyes aimed high and try to anticipate hazards and other drivers' mistakes. You should be looking well ahead of where you are. You should also always leave yourself an out in case the other driver does the unexpected.
- Maintain a safe following distance at all times. Approximately 1/3 of all auto accidents are rear end collisions. You should be at least two seconds behind the vehicle in front of you to allow yourself sufficient time to stop. Do not tailgate. Following distances should be increased for larger vehicles or if in slippery or rainy conditions.
- Avoid passing on two lane roads. Head on collisions are the most common cause of fatalities. You should also turn on your headlights while driving on two lane roads. This helps oncoming traffic see and avoid you. Never pass another vehicle on blind turns or hills.
- You must be sober and alert at all times while driving. The use of drugs or alcohol while driving, or prior to driving, significantly increases your chances of having an accident. It should be at least eight hours from the time you take a drink until operating a vehicle. You should also avoid the use of prescription or over the counter medicines that make you drowsy.
- Inspect the vehicle for mechanical defects prior to each trip. Test your brakes as soon as you start out to insure they are properly operating. Worn tires can make your vehicle difficult to control or stop.
- Avoid dialing the phone, reading maps or other distracting activities while driving. These actions take your eyes off the road and often cause you to swerve. Pull over into a safe parking area before making that call.
- Never drive faster than road conditions warrant. Slow down when road conditions are poor (rain, fog, night) and never exceed posted speed limits.
- Always signal when changing lanes or turning.
- Use caution when passing any stopped vehicle, especially near intersections or cross walks.

- Aggressive driving has become a significant problem in the past few years. Just don't do it. Avoid tailgating, rapid lane changes, speeding, and hand gestures to bad drivers. You never know, they may be armed. If you are being tailgated, change lanes and let them pass. It's really not worth getting killed over.
- Intersection collisions are also a significant problem. These are often caused by someone running the red light. You should always be under control when approaching an intersection and be prepared to stop if the light changes.
- Slow down and look for trains at all railroad crossings. Even with modern signals and gates, hundreds of cars are hit by trains each year at grade crossings.
- Use your low beams while driving in fog and slow down. If you can't see, pull over into a safe parking area and wait for better visibility. Do not stop in the traffic lanes. You will almost certainly be hit by another vehicle if you do.
- Always walk behind the vehicle before backing. This will insure that there are no people or objects behind you that you cannot see from the driver's seat. You should also make sure that all loads are properly secured to prevent them from moving. Numerous accidents are caused by objects that have fallen off company vehicles.
- Always signal well in advance when changing lanes or turning, and make sure to check your blind spot for other vehicles. Also, avoid driving in someone else's blind spot. If they can't see you, they don't know you are there.
- Yield the right of way until you are sure the other driver is going to stop. Just because you have the legal right of way doesn't mean you should always take it. Always yield the right of way to emergency vehicles.

Defensive drivers:

- Expect the unexpected
- Anticipate bad driving by others
- Look ahead for hazards
- Always leave them an out
- Always drive under control
- Obey the rules of the road

What to do if an accident does occur:

- Report all accidents involving government vehicles or nursery vehicles to the fleet manager, Nan Hayes, 561-3001, as soon as possible. Park Police can also be called to the scene if the incident occurs within GGNRA.
- There are accident report Forms in each GSA (Federal) vehicle. These must be completed within 24 hours.

Electrical Safety	
Date of Training	
Trainer name	

Electrical Safety

As nursery employees, we will have limited exposure to electrical maintenance; however, we do use electric power tools and other equipment plugged into electrical circuits. For this reason we should all keep these basic safety rules in mind when using any type of electrical device:

- Do not attempt to operate any switch, valve, or other energy-isolating device bearing a lock.
- Safety grounds shall always be used where there is a danger of shock from back feeding or other hazards.
- Polyester clothing or other flammable types of clothing shall not be worn near electrical circuits.
- All power tools will be grounded or double insulated. Tools with defective cords or wiring shall not be used.
- Metal jewelry should not be worn around energized circuits.
- Extension and temporary power cords must be heavy duty and grounded (three pronged plugs into a three hole outlet). Frayed or defective cords shall not be used.
- Suitable temporary barriers or barricades shall be installed when access to opened enclosures containing exposed energized equipment is not under the control of an authorized person.
- Electrical installations must be protected from accidental contact by enclosures or tight fitting covers.
- Ground Fault Circuit Interrupters (GFCI's) are required on all power outlets.
- Circuits shall not be overloaded with equipment or extension cords.
- Metal measuring tapes, fish tapes, ropes or other metal devices are prohibited where they may contact energized parts of equipment or circuits.

Field Ergonomics and Stretches	
Date of Training	
Trainer name	

Field Ergonomics

The best way to avoid injury while engaging in repetitive motion activities in the field is to alternate work activities every 20 minutes when using tools or techniques while planting. Between activities, walk around for 30 seconds and stretch areas of the body that you have been using.

An example scenario for nursery workers: 4 people are planting 500 plants in one day.

- First lay plants out for everyone to plant in 1 hour (4 ppl x 20 plants= 80 plants).
- Vary planting tool or technique while planting (i.e. switch between handpick and shovel every 20-30 minutes and work as a two person team, alternating tasks between planting and digging).
- Stand and stretch target muscles every hour.
- After 80 plants are planted, stop and get more to lie out.
- Continue this pattern or break up the day's activities even more with other tasks.

Below are practices to further ensure that injury due to improper field techniques can be prevented:

Hand pick use

- Keep wrist straight and work from the elbow/shoulder
- Keep target area in close range of the body in order to prevent overextension
- Use knee pads to protect sensitive knees
- Use padded gloves or padded handle in hard soils
- Specific Stretches: hand/wrist, thumb

Shovel/digging bar

- Change activity every 5 minutes for digging bar
- Use strength of legs and whole body
- Specific stretch: pectoral

Pick mattock use

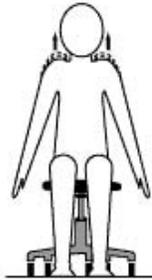
- Best posture: arch back, stick butt out, stand with legs apart, engage stomach muscles
- Change activity every 10 minutes to a standing position activity
- Specific stretch: back

Carrying plant racks/buckets

- Use gloves
- Carry lighter loads and make more trips
- Carry load in arms in front of body

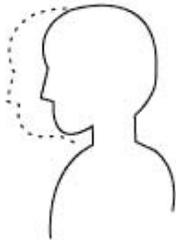
Stretching the Neck & Shoulders

1. Shoulder Shrug: Purpose: to relieve early symptoms of tightness or tension in the shoulder and neck area.



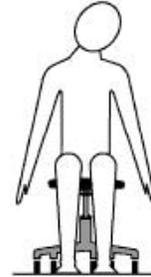
- Raise the top of your shoulders towards your ears until you feel slight tension in your neck and shoulders. Hold this feeling of tension for 3 to 5 seconds. Then relax your shoulders downward into their normal position. Do this 2 or 3 times.

2. Head Glide: Purpose: to stretch your chest, neck and shoulder muscles.



- Sit or stand upright. Without lifting your chin, glide your head straight back. You know you are doing this exercise right if it gives you the feeling of a double chin. Hold for 20 counts and repeat 5 to 10 times.

3. Neck Relaxer: Purpose: helps to relax the neck.



- Sit or stand with a straight back. Inhale. As you exhale, drop your head slowly to the left trying to touch your ear to your shoulder. Repeat on right. Bring head back to centre.
- Inhale, then exhale slowly and drop chin to chest. Inhaling, roll your right ear toward your right shoulder; exhale while bringing chin back toward chest. Repeat to the left.

4. Shoulder Roll: Purpose: to relax the shoulder muscles.



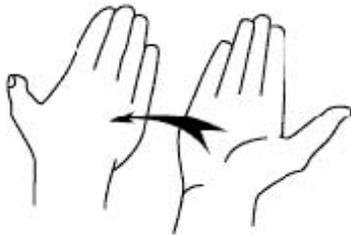
- Inhaling, slowly raise your shoulders towards your ears, and roll them backward 5X in a circular motion. After 2 or 3 rotations, change directions and roll shoulders forward. Ensure you are breathing deeply each time.

Stretching the Hands & Forearms

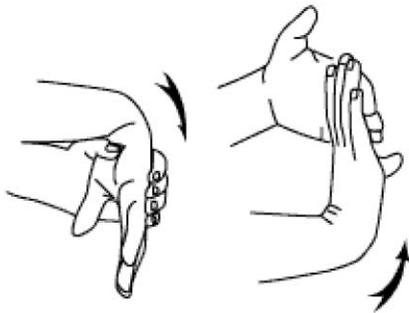
1. With hand open and facing down, gently bend wrist from side to side, as far as possible. Hold for 3 to 5 seconds. Repeat 3 times.



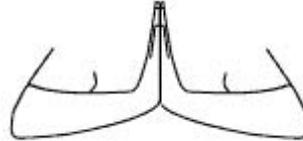
2. Start by stretching your arm and hand out and slowly rotate the wrist down until you feel a stretch. Hold for 3 to 5 seconds. Next, rotate the palm up until you feel a stretch. Repeat 3 times.



3. Grasp hand and hold fingers with the other hand. Slowly bend wrist down until you feel a stretch. Hold for 3 to 5 seconds. Relax. Repeat 3 times. Then slowly bend your wrist up until you feel the stretch. Hold & relax.



4. Sitting with your elbows on the table and palms together, slowly lower wrists to the table until you feel a stretch (your elbows will move outward a bit). Be sure to keep your palms together throughout the stretch. Hold 5 to 7 seconds. Relax. Repeat 3 times.



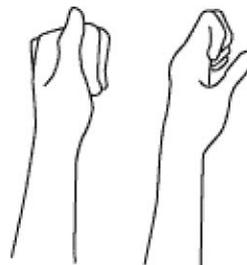
5. a) Start with your hand open.



b) Make a fist. Keep your thumb straight, not tucked under your fingers.



c) Slide your finger tips up your palm so the tips of your fingers are near the base of your fingers and you should feel a stretch. Do not force your fingers with your other hand if something is painful.



Leg Stretches

1. Ankle Flex and Stretch: (this will stretch & work your thigh muscles, ankles, and calf muscles)

- Hold one foot off the floor with your leg straight. Alternately flex your ankle (point your toes up) and extend (point your toes down). Repeat with the other leg.



2. Leg Lift:

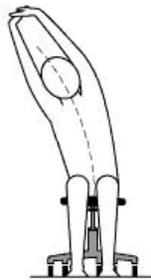
- Sit forward on the chair so that your back is not touching the chair's back. Place feet flat on the floor. With a straight leg, lift one foot a few inches off the floor. Hold momentarily, and return your foot to the floor. Repeat with the other leg.



Back Stretches

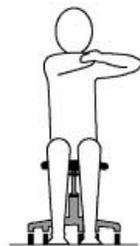
1. Back/Side Stretch:

Interlace your fingers and lift your arms over your head, keeping the elbows straight. Press arms as far back as you can. To stretch your sides, slowly lean to the left and then to the right.



2. Middle/Upper Back Stretch:

- Hold your right arm with your left hand just above the elbow. Gently push your elbow toward your left shoulder. Hold stretch for 5 seconds. Repeat with your left arm.



3. Back Curl: (also stretches your legs)

- Grasp your shin. Lift the leg off the floor. Bend forward (curling your back), and reach your nose to your knee. Repeat with the other leg.



4. Upper Back Stretch: (Also helps stretch your arms, hands, fingers and shoulders)

- Sit or stand tall with your back straight. Interlock your fingers, palms up. Stretch arms above head until straight and hold for 20 seconds. Ensure your tummy muscles are tight and tucked in, and do not arch your back. Relax and repeat. Inhale and exhale with controlled breathing.



5. Standing Back Bends: Purpose:

Stretches the anterior trunk, hips and joints in the lower back.



 Place your hands in the small of your back and slowly bend backwards until you feel a gentle stretch in your trunk. Remember that stretching should not cause any pain. Hold the stretch for 3 seconds and repeat 10 times.

Hanta Virus	
Date of Training	
Trainer name	

Hantavirus

Hantavirus is a rare but frequently fatal rodent-borne virus. Only one rodent in California is known to carry the disease, the deer mouse (*Peromyscus maniculatus*), which is a highly abundant rodent found in all habitat types and is distinguishable by its size (4 to 7 inches), color (grey to brown with white fur on its belly), and large ears. Infected deer mice will not exhibit signs of illness, making it difficult to distinguish between infected and non-infected rodents. For this reason, all rodents should be treated as potentially infectious and all preventative measures should be taken.

Controlling mice in the nurseries

Follow these basic precautions to prevent mice infestation in your nursery or office space:

- Keep food in sealed containers or in the refrigerator.
- Clean up spilled food immediately and use garbage containers with tight fitting lids.
- Keep counters and tables free of food debris.
- Use weather-stripping or brushes on doors.

Rodent proofing your nursery may also help prevent infestation, some helpful practices may include:

- Cover or fill holes in the exterior of nursery buildings; caulking works well to fill holes.
- Move woodpiles, food compost, and trash cans away from nursery buildings or elevate off the ground.

Safety precautions for cleanup

Transmission of the virus occurs primarily by inhalation of aerosols contaminated with virus from rodent secretions. For this reason it is very important to minimize the amount of stirring up of materials into the air when cleaning. Some precautions that should be used when cleaning areas suspected of contamination by rodents include:

- Ventilation of the affected area the night before cleaning.
- Use rubber gloves.
- Apply disinfectant spray at maximum recommendations to dead rodents, rodent droppings, nests, and surrounding areas and allow 15 minutes to pass before removing.
- Wear a respirator (become certified first).
- Use a wet mop for cleanup, never sweep up droppings.
- Lysol or chlorine bleach at a 1:10 dilution are good disinfectants.

Symptoms

Early symptoms of Hantavirus are similar to the common flu and may include fever, headache, muscle aches, vomiting, and abdominal pain. These symptoms may last a few hours to several days. As the illness progresses, the lungs fill up with fluid, making breathing difficult. If have been exposed to rodents or their secretions and develop flu-like symptoms 1-6 weeks after exposure, contact your doctor immediately. There is no specific treatment for the virus other than early diagnosis and treatment of symptoms.

<u>Ladder Safety</u>	
Date of Training	
Trainer name	

- Inspect the ladder before using it. If it is broken, throw it out. Never repair a broken ladder, get a new one. Keep portable stairways, ladders and step stools in good condition and use them only in a safe manner.
- Use the proper ladder for the job. Do not use “A” frame ladders as straight ladders. Make sure the ladder is tall enough to reach the work area. Do not use metal ladders for electrical work.
- Do not place ladders in passageways, doorways, or any location where they might be hit or jarred, unless protected by barricades or guards.
- Ladders should only be placed on hard level surfaces. Make sure the ladder feet are not placed on sandy, slippery, or sloping surfaces. Clean or sweep the area where the ladder feet will be and make sure the rubber feet are in good shape.
- Ladder rungs and steps must be kept free of grease, oil, mud, or other slippery substances.
- Arrange your work so you are able to face the ladder and use both hands while climbing. Do not carry tools or equipment while climbing a ladder. Climb the ladder, and then hoist the tools or equipment with a line or a hoisting device.
- Avoid temporary ladders. Always use a commercially made, construction grade ladder of the proper length for the work being performed.
- Secure portable ladders in place and at a pitch so the leveling indicator is in alignment or the distance from the wall to the base of the ladder is at least 1’ for every 4’ of height.
- Straight ladders shall be tied off the top of the ladder to prevent slipping.
- Be aware of objects below you, move or cover sharp objects in case you fall. Cap or bend all rebar.
- Do not stand on or work from the 2nd rung from the top or above. Also do not reach too far from the ladder. Keep your belt buckle between the side rails.
- Extension ladders shall extend at least 36" above the level being accessed.



Safe Lifting	
Date of Training	
Trainer name	

Lifting Techniques for Back Safety

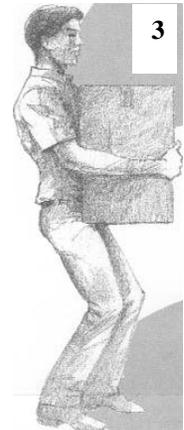


1. Assume a safe lifting position- Squat by bending the hips and knees, keeping the ears, shoulders, and hips, in a generally straight line, perpendicular with the floor or ground.



2. Keep your back in its natural curve - Don't bend your back.

3. Use your legs for lifting - Control the load with your arms and upper body and keep the load close, near you center of gravity.



Before making a lift, make sure:

- The load is stable.
- There are no points to cause an injury and /or dropping the load.
- You have good visibility and have a clear path for moving the load.
- You turn with your feet to move the load, not with your waste.

To unload:

- Bend your knees and lower your body with the load while keeping your back straight. Do not bend over with the load.
- Keep your fingers clear of the bottom of the load.
- If unloading onto a rack or table, set the load on the edge and then push slide it back or over.

Poison Oak	
Date of Training	
Trainer name	

Poison Oak

Recognition

Poison oak (*Toxicodendron diversilobum*) is most notoriously identified by the three leaf rule, “leaves of three let them be.” Although this rule is good to follow, it is important to note that poison oak can be found in many different growth forms, occurring as a vine, shrub, or as low lying ground cover and can exhibit different leaf size morphology. In generally, leaves are glossy, dark green, and deeply lobed; however, the poison oak plant is deciduous and leaves change color in the summer months to bright red, pinkish and orange and fall off completely by early winter.



Precautions

Avoid contact if possible, if avoidance is not possible then protect skin (particularly sensitive areas) by wearing a Tyvek suit (or other oil resistant coveralls) and apply a protective soap prior to exposure (such as Tecnu or Ivy Block). Taking such precautions will reduce the likelihood of exposure to and/or skin penetration of the oily sap of the plant called *urioshol* that causes allergic reaction. All parts of the poison oak plant contain urioshol oil so it is possible to become exposed to the plant even after all the leaves have fallen.

Decontamination

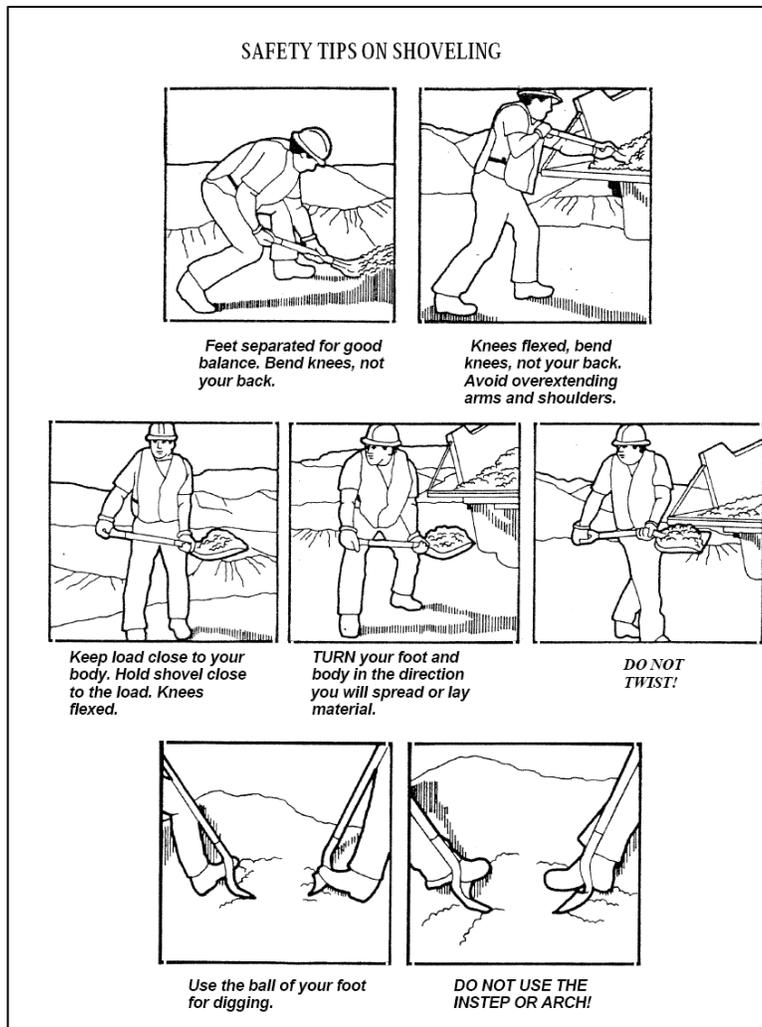
If exposed to poison oak, wash the infected are with soap and water as soon as possible, waiting more than two hours to treat the exposed are increases the likelihood of infection. Using soap (or Tecnu), wash the skin for two minutes using cold water. Be aware of contamination of clothing and tools; wash these items after exposure as well. If infection does occur, allergic rashes may appear in one day or take three days and can continue to appear for as long as a week after exposure. Less severe allergic reactions can be treated with antihistamine and anti-itching medications; however, more severe infections or infections occur very close to the eyes should be examined by a doctor.

Participants	
Name printed	Signature

Shovel Safety	
Date of Training	
Trainer name	

Before you begin an activity that requires the use of the shovel be sure to check that the shovel you will be using is in good working order, for examples check that the handle is not splintering. Also make sure that you have the proper PPE, which includes gloves and sturdy work boots or shoes. Some tips for using a shovel safely include:

- Keep your feet separated for good balance and keep your knees flexed.
- Use the proper shovel for the task at hand: a short handled shovel can be used for spreading material while a long-handled shovel should be used for digging and carrying materials.
- Gradually increase the amount of material you are loading to make sure that you are not carrying or moving more than you can handle.
- Bend your knees but not your back when shoveling.
- Keep your arms and elbow close to your body when moving materials.
- **Never** twist your body when lying out or spreading material, instead turn your foot and body in the direction you intend to spread or lay out the material.
- For digging, use the ball of your foot (not the arch) to press the shovel into the dirt.



Participants	
Name printed	Signature

<u>Sun Exposure</u>	
Date of Training	
Trainer name	

Sun Exposure

As a nursery staff member or intern, you will likely spend extended periods working in the outdoors and thus will greatly increase your risk to hazards from sun exposure. For this reason, it is important to always keep in mind what these hazards are and how to best protect yourself from these hazards, which may include sunburn, increased risk to skin cancer, and heat exhaustion.

Ways to protect yourself from sunburn and skin cancer

- **Generously apply sunscreen!** and reapply throughout the day.
- Wear a hat to protect your face and neck
- Wear a long sleeved shirt made from light material.

Tips for correct use of sunscreen

- For maximum effectiveness, apply a sunscreen that blocks both UVB and UVA light 20 to 30 minutes before your start working outside.
- Use a generous amount and use a sunscreen product with a sun protection factor (SPF) of 15 or higher.
- For best results, reapply every two hours and immediately after intense sweating.

Ways to protect yourself from heat exhaustion

Heat exhaustion or heat stress occurs when your normal body temperature becomes elevated and your body loses the ability to respond to transfer heat out of your body to keep you cool (by sweating and increasing blood flow to the skin). Heat related illness can occur when you are working and exercising for long hours in the field and are often caused or made worse by dehydration and fatigue. Some ways to prevent heat illnesses include:

- On particularly hot days, designate field sites in the shade whenever possible.
- Bring plenty of water to your work site and be sure to hydrate every hour.
- Wear appropriate clothing that will protect you from the sun.
- Be aware of medications that may increase your risk and the risk of volunteers to heat-related illnesses.

Some signs of heat illness include:

- Heat rash (prickly heat), which occurs when the sweat ducts to the skin become blocked, swells, and cause discomfort and itching.
- Heat cramps, which occur in muscles after exercise because sweating causes the body to lose water and salt and minerals (electrolytes).
- Heat edema (swelling) in the legs and hands, which can occur when you sit or stand for a long time in a hot environment.
- Heat tetany (hyperventilation and heat stress), which is usually caused by short periods of stress in a hot environment.
- Heat syncope (fainting), which occurs from low blood pressure when heat causes the blood vessels to expand (dilate) and body fluids move into the legs because of gravity.

West Niles Virus	
Date of Training	
Trainer name	

West Nile Virus

West Nile virus is an arbovirus (arthropodborne virus) transmitted by blood feeding insects such as mosquitoes that causes encephalitis or inflammation of the brain. Primarily, West Nile is transmitted to animals or humans from an infected bird via an insect carrier and cannot be transmitted directly from animal to person, person to animal, or person to person.

Prevention

The best form of prevention from contracting West Niles virus is to limited exposure to mosquitoes. As nursery employees, we are often required to work in the outdoors and have a higher risk of coming into contact with mosquitoes. In general, you can reduce your risk of being bitten by:

- Avoiding working during dawn and dusk when mosquitoes are most active.
- If necessary to work for extended periods during these times of day you can prevent being bitten by: wearing long-sleeved shirts, long pants, a hat, and gloves and use an insect repellent on clothes or sparingly on exposed skin.
- Use a repellent with 20-30% DEET as the active ingredient.
- A head net and net coat can be used as a form of protection on warm days.
- Also, to prevent mosquitoes from being attracted to nursery buildings avoid keeping buckets of standing water in and near the nursery.

Diagnosis and Treatment

Symptoms of West Nile virus may vary from no symptoms at all to mild symptoms including fever, headache, and body aches, often with skin rash and swollen lymph glands. Severe infections may include headache with high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and rarely, death. Blood tests can confirm infection of West Nile; if you experience some or all of the listed symptoms and have been recently been bitten by a mosquito(s), you should see your primary care physician to be tested for the virus. Treatment for the virus is often not specific and may vary depending upon your symptoms and complications as they develop.

Participants	
Name printed	Signature

<u>Yellowjackets</u>	
Date of Training	
Trainer name	

Working around yellowjackets

It is common to come across yellow jackets in the field, especially in more urban areas of the park. Yellow jackets commonly take over abandoned rodent holes and build nests underground, although they do build aerial nests. They will defend their nests vigorously when disturbed. Our native yellow jackets nest in the ground, making their hives extremely hard to detect and easy to step on. However, if you keep a watchful eye, the native hives can be spotted by observing a steady stream of yellow jackets flying in and out of an area. This area could be on the bare ground, making it relatively easy to see, or it may be in a bramble of blackberry, in a shrub, or in ice plant, making it not so easy to detect. Some things to keep in mind when working out in the field or in a nursery nearby a hive include:

- Defensive behavior begins in the spring and increases as food becomes scarce in the fall. For this reason, it is a good idea to scope out field sites and around the nursery for hives and avoid working in these areas during these times of year.
- Yellow jackets will usually only attack when they perceive something as a threat to their nest.
- Yellow jackets can sting repeatedly unlike bees; therefore it is best to run away from the area as quickly as possible. Zigzag patterns make it difficult for them to follow you but do not swat at them, as yellow jackets react aggressive to fast movements.

Allergies to yellow jacket stings

It is hard to know if you are allergic to yellow jackets unless you have been stung before, furthermore, how allergic you are to stings can be difficult to determine because venom can build up in your bloodstream over a lifetime, causing your reaction to increase each time you are stung. Most non-allergic people experience piercing pain at the site of the bite for about five minutes; others may experience a more severe reaction that may include varying degrees of swelling around the bite and pain at the site for up to a few days.

Participants	
Name printed	Signature