FINAL REPORT

MITIGATION-RELATED TRANSPLANTATION, RELOCATION AND REINTRODUCTION PROJECTS INVOLVING ENDANGERED AND THREATENED, AND RARE PLANT SPECIES IN CALIFORNIA

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I. EXECUTIVE SUMMARY

To investigate the efficacy and overall success of transplantation, relocation, and reintroduction of California State-listed endangered, threatened, and rare species, a questionnaire was mailed to 377 individuals, state and federal agencies, and public and private institutions that potentially have been involved in transplantation, relocation, and reintroduction projects. One hundred sixty-eight questionnaires (168) were returned. Of these, twenty-four (24) individuals and/or agencies indicate that they have been directly involved in mitigation-related projects for California plants; one hundred fourteen (114) individuals and/or agencies have not. At minimum, this represents a 45% return rate for the questionnaire.

Files of California Department of Fish and Game's Endangered Plant Program were also reviewed to complete the survey. An additional 13 projects involving eight (8) State-listed species were identified as of these types. Information obtained from the Endangered Plant Program files supplemented 13 responses to the questionnaire.

This report summarizes the results of the questionnaire for each species identified by the respondents and information obtained from the Endangered Plant Program's files. A total of forty-six (46) projects were reviewed, involving fifty-three (53) transplantation, relocation and reintroduction attempts with forty (40) special status species. Of the plant species examined in this review, 25 (63%) are listed by the State as endangered, 3 (8%) are listed as threatened, 6 (15%) are listed as rare, and 6 (15%) are not listed by the State, but have some other form of protection or special status.

In addition, the 40 plant species reviewed belong to 21 plant families. Asteraceae represented the highest number of species involved (9; 23%), followed by the Brassicaceae (4; 10%). Eight (8) additional plant families were represented by two taxa, while ten (10) families were represented in this study by one taxon. The genus *Erysimum* had the greatest number of taxa (3) involved, followed by the genera *Brodiaea, Hemizonia, Lupinus*, and *Oenothera* (2 each).

Results of the survey indicate that of the 46 projects reviewed, 38 (83%) are mitigation-related, while eight (8) projects (17%) are research-related. Of the 53 manipulation attempts, forty-one (41; 77%) involved translocation (including relocation) of species of concern, nine (9) projects (17%) involved reintroduction, and 2 projects (4%) involved restoration of a population of a State-listed species. One additional project reviewed is a research-related project that has yet to include a transplantation, relocation or restoration component.

Thirty-six (36) projects have been implemented, while ten (10) projects are still in the planning stages. Seventeen projects (27%) are developments for housing, business parks, or recreational facilities initiated by private companies and corporations. Eleven projects (24%) are the result of state service operations, such as those by the California Department of Transportation and Department of Water Resources. The remaining projects are either initiated by county services (9%), private and public energy utilities (11%), or are research related. Of the total 46 projects, only 15 projects (33%) had explicitly defined criteria for success of the mitigation project, while

the remaining 31 (67%) either had no criteria for success or the criteria were only vaguely defined.

Only 15% (8) of the 53 transplantation, relocation, or reintroduction attempts reviewed should be considered fully successful (13% of the 46 projects). Plant species for which the project was successful included *Amsinckia grandiflora, Dudleya cymosa* ssp. *marcescens, Holocarpha macradenia, Lasthenia burkei, Opuntia basilaris* var. *treleasei*, and *Sidalcea pedata*. However, of these eight (8) projects, only four (4) are mitigation-related. Therefore, the success rate of the mitigation-related transplantation, relocation, and reintroduction attempts is 8% (9% of the projects). An additional seven (7) transplantation projects (13%) (9 attempts [17%]) are considered partially successful, or of limited success. Twelve (12) projects (26%) are considered here to be unsuccessful, no information was found in the review of files for four (4) projects (9%), and the success of an additional sixteen (16) projects (35%) could not be evaluated because they are on-going or in the planning stages.

In a summary review of the successes and failures of transplantation, relocation and reintroduction of sensitive plant species in California, three broad recommendations can be made that are based on crucial aspects of the biology of imperiled plant species. These recommendations are:

(1) Individuals should be removed with as little physical disturbance as possible to the individual, and at a phenologically appropriate time of year, as when the individual is dormant or photosynthetically inactive;

(2) The receptor site should be of the same habitat quality, particularly with respect to soil type and its physical characteristics. Various other manipulation aspects of the receptor site may include weeding to decrease competition from native and exotic species, watering during times of drought, and fencing and/or other forms of site protection; and

(3) Knowledge of the biology of the organism appears to aid greatly in the design of appropriate horticultural techniques for the preparation of cuttings, transplantation, seed germination, *etc.* This is problematic, however, because the biology of most State-listed species is poorly known. Although some species such as cacti and succulents may be amenable to standard horticultural techniques for propagation, most are not. Therefore, without sufficient knowledge of the biology of impacted species, success of the transplantation, relocation, or reintroduction will not be assured.

Finally, it is suggested that because of the lack of or limited success (21; 32% combined) of most of the transplantation, reintroduction, or restoration attempts documented, and the uncertainty of many of the on-going projects, the Endangered Plant Program of the California Department of Fish and Game's Natural Heritage Division should remain extremely cautious in any mitigation agreement that will allow any of these techniques to serve as mitigation for project impacts.

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II. INTRODUCTION AND PROJECT OBJECTIVES

The Endangered Plant Program (EPP) of the California Department of Fish and Game (CDFG) requested that mitigation-related transplantation, relocation, and reintroduction projects involving the State's endangered, threatened, and rare plant species be assessed for overall project efficacy and success. Thus the purpose of this research is to document the results of mitigation-related projects of this type involving the State's rare plant species of concern. The documentation may serve in the future as a position paper for the EPP's policy on transplantation, relocation, and reintroduction of State-listed species as mitigation.

The Department of Fish and Game currently requires an approved Mitigation Agreement (MA) for the manipulation of State-listed species (*cf.* Howald and Wickenheiser 1990). An MA is the legal document used by CDFG to approve mitigation projects for State-listed species that are required under the California Environmental Quality Act, Statutes, and Guidelines (CEQA). Mitigation is not explicitly defined in CEQA, but is listed as "including":

> (a) Avoiding the impact altogether by not taking a certain action or parts of an action.
>
> (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
>
> (c) Rectifying the impact by repairing, rehabilitating, or restoring the impacted environment.
>
> (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
>
> (e) compensating for the impact by replacing or providing substitute resources or environments (CEQA §15370).

If these five forms of mitigation are interpreted as priority in order of listing, then the preferred form of mitigation under CEQA (1986) is project avoidance, followed by minimization of impacts, rectification of impacts, *etc.* It should be noted that compensation is the least preferable form of

mitigation under this interpretation.

III. METHODS

Questionnaire: To begin the assessment, a questionnaire was developed by the author and reviewed by members of the CDFG's Endangered Plant Program. Three hundred seventy-seven (377) individual questionnaires were sent in the summer of 1989, along with, at that time, a current list of State-listed endangered, threatened, and rare plant species (California Department of Fish and Game 1989), to a broad spectrum of public resource and land management agencies, consulting firms, nurseries, museums, academic institutions, and private individuals or conservation organizations (Table 1). The individuals selected for the survey were compiled from California Native Plant Society and California Department of Fish and Game files, and personal mailing lists. The questionnaire and cover letter are included as Appendix A. The mailing list is included as Appendix B.

Review of Internal Files: Project and species files held by the EPP were reviewed in the winter of 1990, to clarify materials received from the questionnaire and to gather additional information. These files were particularly helpful regarding the MOU and MA conditions of the mitigation-related projects. Most, but not all of the current (*i.e.*, on-going and/or currently negotiated) mitigation-related transplantation, relocation, and reintroduction projects were reviewed. However, several recently initiated and on-going projects that conform to newly instituted EPP mitigation standards are not reviewed in this document because assessment of their success is not possible at this time.

Mitigation Project Assessment: The questionnaires received and EPP files reviewed were examined for the following information:

(1) whether the project reported was mitigation- or research-related,

(2) mitigation project objective(s),

(3) responsible party's criteria for mitigation success,

(4) transplantation, relocation, or reintroduction methods,

(5) design and implementation of the mitigated population's monitoring plan,

(6) respondent's assessment of mitigation project success, and

(7) date of transplantation, reintroduction, or relocation project.

Once these data were compiled, the projects were tallied for their assessed success and efficacy. The results of this analysis are summarized in Section IV.

IV. RESULTS

A total of one hundred sixty-eight (168) questionnaires was returned for this survey. All those organizations and individuals who responded to the questionnaire, and their summary responses are listed in Appendix C.

The majority of respondents (114, 68%) have not been involved in any transplantation, relocation, or reintroduction project involving state- (or federally-) listed endangered, threatened, or rare plant species. Twenty-four (24) individuals have been involved, however, and they are reviewed in detail in Section IV.A and IV.B. Table 2 outlines the responses to questionnaire.

A significant number of respondents reported on transplantation, relocation, and reintroduction projects that were not mitigation-related, but rather, research-related. Mitigation-related projects are defined as those that required either an MA or formerly, a Memorandum of Understanding (MOU). Thus several of the projects described in the returned questionnaires were research activities that did not require a Mitigation Agreement (MA). These projects were included in the analysis, and are described in Section IV.B. However, the listing is not exhaustive for research-

TABLE 1. SUMMARY OF RECIPIENTS OF THE MITIGATION QUESTIONNAIRE

Organization or Individual	Number[1]
Consulting Firms	66
Resource Agencies	
Federal	9 (30)[2]
State	10 (43)[3]
County	10 (15)[4]
City	3[5]
Private Nature Preserves	7
Museums	7
Private Energy Companies	1
Public Utilities	4
Private Conservation Organizations	4
Botanic Gardens	6
Nurseries	4
Universities	20 (29)[6]

[1]The number of questionnaires will not sum to a total of 377 because in many cases several individuals within the same office were sent a questionnaire. Therefore, although the questionnaire may have been duplicated within any one office, the probability of receiving a response was increased.

[2]The first number in this column represent the total number of different federal agencies queried. These included the U.S. Fish and Wildlife Service, U.S. National Park Service, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Bureau of Land Management, U.S. Soil Conservation Service, U.S. Air Force, U.S. Navy, and the U.S. Forest Service. The number in parentheses indicates the total number of federal agency offices contacted.

[3]The first number in this column represents the total number of different state resource agencies queried. These included the California Department of Fish and Game, Department of Forestry, Department of Transportation, Jackson State Forest, State Lands Commission, California Conservation Corps, California Department of Parks and Recreation, Department of Water Resources, Department of Food and Agriculture, and the Division of Mines and Geology.
The number in parentheses indicates the total number of state offices contacted.

[4]The first number represents the total number of county offices queried. These include planning and resource offices in the following ten counties: Chico, Placer, San Diego, San Luis Obispo, Sacramento, Santa Barbara, Solano, Sonoma, Tuolumne, and Yolo. The number in parentheses represents the total number of county offices contacted.

[5]Planning and resource agencies were contacted in the cities of Santa Rosa, Modesto, and San Diego.

[6]The first number in this column represents the total number of different colleges and universities queried, including American River College; Butte College; California Polytechnic Pomona; California State Universities at Bakersfield, Chico, Hayward, Humbolt, Sacramento, San Diego, San Francisco, San Jose, and San Luis Obispo; Mills College; Pacific Union College; Palomar College; Stanford University; University of California at Berkeley, Davis, Santa Barbara, and University of San Diego.

TABLE 2. SUMMARY OF RESPONSES TO MITIGATION QUESTIONNAIRE

Organization	Number of Questionnaires Sent	Responded Yes	Responded No[7]
Private Individuals/			
Citizen Groups	90	2	24
Consulting Firms	66	6	18
Resource Agencies			
State Agency Offices	10 (44)[8]	11	9
Federal Agency Offices	9 (30)	7	13
County Offices	10 (15)	4	9
City			
University Faculty	20 (29)	5	11
Museums	7	0	3
Private Nature Preserves	7	0	3
Botanic Gardens	6	1	2
Nurseries	4	1	1
Public Utilities	4	0	3
Private Conservation Organizations	4	0	1

[7]In all cases in this table, the total number of respondents will not total to 168 because multiple individuals were contacted within a single office or agency, and therefore multiple questionnaires were returned from a single office or agency.

[8]In all cases, first number in the column represents the total number of agencies queried, and the number in parentheses represents the total number of offices contacted.

related transplantation, relocation, and reintroduction projects, but it is considered nearly so for completed mitigation-related projects of these types.

A total of forty-six (46) projects were review, involving 53 transplantation, relocation, or reintroduction efforts. Forty (40) plant species were reviewed, 34 (85%) are listed by the State, federal goverment, or the California Native Plant Society as either endangered, threatened, or rare. Specifically, 25 (63%) are listed by the State as endangered, 3 (8%) are listed asthreatened, and 6 (15%) are listed as rare, and 6 (15%) are not listed by the State, but have some other form of protection or special status (California Department of Fish and Game 1990, Smith and Berg 1988).

In addition, the 40 plant species reviewed belonged to 21 plant families. Asteraceae represented the highest number of species involved (9; 23%) including species in the genera *Blennosperma, Cirsium, Eriophyllum, Hemizonia, Lasthenia*, and *Pentachaeta*. This was followed by the Brassicaceae (4; 10%), encompassing the genera *Arabis, Eryngium*, and *Erysimum*. Eight additional plant families were represented by two taxa, while ten families were represented in this study by one taxon. The genus *Erysimum* had the greatest number of taxa (3) involved in this study, followed by the genera *Brodiaea, Hemizonia, Lupinus*, and *Oenothera* (2 each).

Additional results of the survey indicate that of the 46 projects reviewed, 38 (83%) are mitigation-related, while eight (17%) are research-related. Of the 53 manipulation attempts, forty-one (41; 77%) involved translocation (including relocation) of species of concern, nine (9) projects (17%) involved reintroduction, and 2 projects (4%) involved restoration of a population of a State-listed species. One additional project reviewed is a research-related project that has yet to include a transplantation, relocation or restoration component.

Of the 46 projects reviewed, 40 projects have been implemented, while 4 projects are in the

planning stages. Of the total 46 projects, only 15 projects (33%) had explicitly defined criteria for success of the mitigation project, while the remaining 31 projects (67%) either had not criteria for success or the criteria were only vaguely defined.

Only 15% (8) of the 53 transplantation, relocation, or reintroduction attempts reviewed should be considered fully successful (13% of the 46 projects). I define "success" in this survey as either: (1) the respondent to the questionnaire felt that the project was successful; or, (2) greater than 75% of the mitigation propagules established a reproducing population over the life of the project as reported. "Unsuccessful" projects were determined to be so in this survey because either: (1) the respondent in the questionnaire reported that the project was unsuccessful; or, (2) less than 25% of the mitigation propagules established a population, and subsequently died. "Limited success" was assigned to those projects for which: (1) the respondent in the questionnaire reported as "limited" or "partially" successful; or, (2) the respondent reported a middle range of mitigation propagule establishment (>25% but <75%).

Plant species for which the transplantation, relocation, or reintroduction project was successful included *Amsinckia grandiflora, Dudley cymosa* ssp. *marcescens, Holocarpha macradenia, Lasthenia burkei* (3 projects), *Opuntia basilaris* var. *treleasei*, and *Sidalcea pedata*. However, of the eight projects involving these species, only four are mitigation-related; therefore the success rate of the mitigation-related attempts is 8%. An additional seven (7) transplantation attempts (13%) are considered partially successful, or of limited success. Twelve (12) of the 53 attempts (23%) are considered here to be unsuccessful, and the success of an additional four projects is unknown (*i.e.*, unreported or no information was found in EPP files). Sixteen projects (35%) could not be evaluated for their success because they are on-going or in the planning stages.

IV.A. Rare, Threatened and Endangered Plant Species Involved in Mitigation-Related Transplantation, Relocation and Reintroduction Projects

The following is a discussion of the state- (and federally-) listed species that have been the subject of mitigation-related transplantation, relocation and reintroduction projects, as outlined by the respondents of the questionnaire and a review of the EPP files. Table 3 lists the endangered, threatened and rare plant species involved in transplantation, relocation, and reintroduction projects. Information from the questionnaire and EPP files is summarized briefly by species. Questionnaires and personal notes are on file and available for review of additional information.

IV.A.1. *Acanthomintha ilicifolia* (San Diego Thornmint): State endangered; Federally Candidate Category 1, CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: "Westview Planned Residential Development." The Pardee Company agreed to mitigate for destruction of a population of *A. ilicifolia* by the construction of a road (Black Mountain Road) and a housing development by creating a 13.6 acre on-site open space preserve for the San Diego thorn-mint.

Mitigation-Related?: Yes.

Project Objectives: The goal of the mitigation plan was to create a viable population of *A. ilicifolia* in an on-site preserve through the importation of seed and soil.

Project Methods: The Pardee Company contracted with Environmental and Energy Services Company (ERC) to salvage all the *Acanthomintha ilicifolia* seeds in the population affected by the construction. Approximately 10.8 gm. of seed were collected in July 1988. Topsoil was then salvaged from the *Acanthominta ilicifolia* population area to collect seed potentially stored in the soil. The soil was transported to the mitigation site.

TABLE 3. CALIFORNIA STATE ENDANGERED, THREATENED, AND RARE PLANT SPECIES INVOLVED IN MITIGATION-RELATED OR RESEARCH-RELATED TRANSPLANTATION, RELOCATION, OR REINTRODUCTION PROJECTS

SPECIES	FAMILY	PROTECTION STATUS[9]
Acanthomintha ilicifolia	Lamiaceae	Endangered
Amsinckia grandiflora	Boraginaceae	Endangered
Antennaria flagellaris	Caryophyllaceae	None
Arabis macdonaldiana	Brassicaceae	Endangered
Arctostaphylos hookeri var. *ravenii*	Ericaceae	Endangered
Bensoniella oregana	Saxifragaceae	Rare
Blennosperma bakeri	Asteraceae	Rare
Brodiaea filifolia	Amaryllidaceae	Endangered
Brodiaea insignis	Amaryllidaceae	Endangered
Calochortus greenei	Liliaceae	None (Fed C2)
Chorizanthe howellii	Polygonaceae	Threatened
Cirsium occidentale var. *compactum*	Asteraceae	None (Fed C2)
Cordylanthus palmatus	Scrophulariaceae	Endangered
Croton wigginsii	Euphorbiaceae	Rare
Dudley cymosa ssp. *marcescens*	Crassulaceae	Rare
Eriastrum densifolium ssp. *sanctorum*	Polemoniaceae	Endangered
Eriophyllum mohavense	Asteraceae	None (Fed C2)
Eryngium aristulatum var. *parishii*	Apiaceae	Endangered
Erysimum capitatum var. *angustatum*	Brassicaceae	Endangered
Erysimum menziesii	Brassicaceae	Endangered
Erysimum teretifolium	Brassicaceae	Endangered
Gilia tenuiflora ssp. *arenaria*	Polemoniaceae	Threatened
Hemizonia increscens ssp. *villosa*	Asteraceae	Endangered
Hemizonia minthornii	Asteraceae	Rare
Holocarpha macradenia	Asteraceae	Endangered
Lasthenia burkei	Asteraceae	Endangered
Lilaeopsis masonii	Apiaceae	Rare
Lupinus tidestromii var. *tidestromii*	Fabaceae	Endangered
Lupinus milo-bakeri	Fabaceae	Threatened
Mahonia nevinii	Berberidaceae	Endangered
Monardella linoides ssp. *viminea*	Lamiaceae	Endangered
Oenothera deltoides ssp. *howellii*	Onagraceae	Endangered
Oenothera wolfii	Onagraceae	None (Fed C2)
Opuntia basilaris var. *treleasei*	Cactaceae	Endangered
Orcuttia viscida	Poaceae	Endangered
Pentachaeta lyonii	Asteraceae	Endangered
Pogogyne abramsii	Scrophulariaceae	Endangered
Pseudobahia peirsonii	Asteraceae	Endangered
Sedum albomarginatum	Crassulaceae	None (Fed C1)
Sidalcea pedata	Malvaceae	Endangered

[9]State of California, Department of Fish and Game, Nongame-Heritage Program, Endangered Plant Project. Designated Endangered, Threatened or Rare Plants. 1990.

Twenty-five (25) 4 ft^2 experimental plots in the preserve were located and prepared by removing existing vegetation. Seeds sown in the test plots were observed in December, 1988, while the remaining seed was sent to the Rancho Santa Ana Botanic Garden (RSA) for germination tests.

Seedlings occurred in 12 of the 25 test plots in March 1989. At the time of the preparation of this report, no additional information is available. However, the MOU on file requires a monitoring program to be established in the mitigation plots that must continue for five (5) growing seasons.

Criteria for Success: As outlined by the MOU, performance criteria include: (1) erosion control [soil stabilized]; (2) weed invasion [no interference with *A. ilicifolia* establishment]; (3) herbivory ["minimal" damage to *A. ilicifolia* seedlings]; (4) vigor [5 cm minimum height per individual plant]; and, (5) reproductive success [to be determined on the basis of offsite monitoring].

Project Success: Project on-going.

Date Project Initiated: July 1988.

2) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Shea Homes Palos Vista Development." Shea Homes designed a development of 979 acres within the city of Escondido that involved the construction of 730 homes and some open space. Shea Homes contracted initially (October 1988) with Royce B. Riggins and Associates (RBR), working in conjunction with Mr. Jim Dillane of the Lake Hodges Native Plant Club, to prepare the biological reports and initial mitigation design for the project. In May, 1989, ERC completed the work initiated by RBR. The mitigation site was selected as the San Diego Wild Animal Park.

Mitigation-Related?: Yes.

Project Objectives: The goal of the mitigation contract was to assure the preservation of

two small disjunct populations of *Acanthomintha ilicifolia* that were originally located within the boundaries of the Palos Vista residential development.

Project Methods: Plants were collected in June and July of 1988 and transplanted to the mitigation site. The site is a 40 x 30 ft parcel on which a 2 ft layer of subsoil was imported and laid down prior to transplantation.

Criteria for Success: As outlined by the MOU on file, performance criteria are based on reproductive success, as follows: (1) number of plants shall equal or exceed 30% of the mean density of plants in natural populations at the first end of the growing season; (2) number of plants shall equal or exceed 50% of the mean density of plants in natural populations at the end of the second growing season; (3) number of plants shall equal or exceed 70% of the mean density of plants in natural populations at the end of the third growing season; (4) number of plants shall equal or exceed 90% of the mean density of plants in natural populations at the end of the fourth growing season; and, (5) number of plants shall equal or exceed 100% of the mean density of plants in natural populations at the end of the fifth growing season.

Project Success: Project on-going.

Date Project Initiated: December 1988.

3) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Reparation for the Sabre Springs Development." One of the largest known populations of *Acanthomintha ilicifolia* is located on property located within the City of San Diego Open Space System, previously owned by the Pardee Company. In the spring of 1989, the population was reduced by one-third due to an accidental road grading operation. In order to avoid prosecution by the State for these damages, Pardee Company was notified of several measures to rectify the damage. Pardee Company has or is complying with all seven conditions of the reparation plan, but with

varying degrees of success.

Mitigation-Related?: Yes.

Project Objectives: To rectify the accidental damage inflicted on a large population of *Acanthomintha ilicifolia*

Project Methods: The disturbed population was fenced and bermed, signed, weeded, and the adjacent roadbed hydroseeded. A second phase of the project will be to manage suitable *Acanthomintha ilicifolia* areas near existing populations to encourage their spread. Seed will be broadcast onto suitable clay soils adjacent to extant stands in January, 1992.

Criteria for Success: As stated in the reparation plan, the goal of the project is to increase the remaining *Acanthomintha ilicifolia* population to predisturbance size or greater.

Project Success: Project on-going.

Date Project Initiated: Spring-summer 1989.

4) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Indian Hill," "McIntire" ("Las Brisas"), and "Spyglass" urban development projects. The three projects together required translocation of *Acanthomintha ilicifolia* to open space areas on the development sites. Mitigation projects were contracted to Pacific Southwest Biological Services (PSBS) of San Diego. PSBS was responsible for all relocation activities, including seed collection, and excavation and placement of clay soils associated with *Acanthomintha ilicifolia* (PSBS, Inc. 1988).

Mitigation-Related?: Yes.

Project Objectives: None stated. Presumably the project objectives were to establish viable populations of *Acanthomintha ilicifolia* from transplanted plant material at four translocation sites (open space areas onsite at the Las Brisas and Indian Hill sites; within a natural, dedicated open space area at the El Camino Condominium and Tennis Club; a project adjacent to the Spyglass project; and within the natural area of the Quail Botanical Garden

County Park.

Project Methods: Seeds were collected at Jetton Property (Las Brisas Mobile Home Park) during the summer of 1986 and sewn by hand on the relocated clay lens. Soils were excavated and prepared for seeding within a 24-hour period. Seeds were collected as whole plant material, occupying approximately 1/2 yd^3 and weighing about 2 pounds.

Criteria for Success: None state specifically.

Project Success: The project was halted and the MOU terminated due to the difficulty the EPP had in dealing with PSBS. Success of the transplantation was limited as of May 1988. However, at the Las Brisas relocation site in May 1988, an estimate of between 700-1000 individuals (1100 "flowering heads") was reported. At the Quail Gardens relocation site, the population estimate was made during the seedling stage. As of 8 May 1988, "seed heads" numbered 70, while the population survey during the seedling stage resulted in 200-300 plants. PSBS reported that associated native plant species were abundant at the Las Brisas site, though more rare at Quail Gardens.

Date Project Initiated: Spring 1985

IV.A.2. *Blennosperma bakeri* (Sonoma Sunshine): Not state listed; Federal Candidate C2; CNPS List 1B.

1) Respondent: Mr. Charlie Patterson, Plant Ecologist. Private Consultant, El Cerrito.

Project Name and Description: "Montclair Park." Project involved the construction of a small housing development by Christopherson Homes in the city of Sonoma (lead agency for the permit). entitled "Montclair Park." The mitigation included the dedication (as compensation) of approximately 2.0 acres of undeveloped land, located on the edge of the development, within which up to 1.0 acres of actual vernal pool habitat would be created and seeded with *Blennosperma bakeri* and associated vernal pool species.

Mitigation-Related?: Yes.

Project Objectives: Objectives for the housing development were the replacement of 0.3 to 0.5 acres of wetlands and of the pre-existing 10,000 individuals of *Blennosperma bakeri* that were destroyed during the construction of the housing development.

Project Methods: The habitat was graded and shaped, creating approximately 10 new vernal pools in a soil that is underlain by the same clayplan existing under the destroyed pools.

Blennosperma bakeri seeds were collected in late May 1989 by collecting the dry flower heads, vacuuming the surface for seeds, duff and dust, and scraping by hoe, 1-2 inches of the top soil of existing pools. Collected seed and duff was air-dried in shallow trays in a cool, dry environment. Seeds were transferred to the created pools by hand. The created pools were fenced (wood and wire) and a berm constructed for protection.

The project design also included several additional trial vernal pools within a storm runoff detention basin to investigate the feasibility of managing detention basins and vernal pools concurrently as a contaminant settling basin.

Monitoring of the pools includes: (1) habitat integrity and stability; (2) *Blennosperma bakeri* growth and reproduction; and, (3) overall vernal pool community development.

Criteria for Success: Essentially the replacement of a self-sustaining colony of *Blennosperma bakeri.* This includes: (1) at least 75% of the created vernal pool habitat should be documented as stable, with no measurable erosion or deposition, and with no significant channel formation; (2) at least 75% of the pools should have adequate [undefined] water-holding capacity; (3) local drainage patterns should be shown to be adequate [undefined] to fill the pools (75%) without input from street runoff or eucalyptus debris; (4) at least 10 colonies of *B. bakeri* should be established in the new pools, and be self-sustaining populations; (5) the total habitat area of at least 0.3 acres should be dominated by *Blennosperma bakeri* for at least 2 years without supplement seeding; (6) the

total population should number at least 10,000 individuals without supplemental seed over 2 years; (7) at least 75% of the total pool habitat should be dominated by typical (native?) vernal pool plants; (8) each pool should contain at least 4 (native?) vernal pool species; and, (9) encroachment by grasses and/or upland weeds should be documented as stable, with no significant advancement into the pools over the last 2 years of the monitoring program.

Project Success: Respondent felt that, after one dry year, the results are promising -- *i.e.*, several thousand individuals of *Blennosperma bakeri* are established. However, the pools need to be regraded and probably deepened.

Date Project Initiated: 1989.

2) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Santa Rosa Rare Plants Mitigation Plan San Miguel Estates 1." In 1989 Cobblestone Development Corporation proposed the development of San Miguel Rancho Subdivision (RSM) at 2001 Waltzer Road within the city of Santa Rosa, Sonoma County and San Miguel Estates No. 2 (SME) at 2192 Francisco Avenue, also within Santa Rosa. The SME project is an on-going housing construction and the RSM housing project was a 1989 development. The projects would destroy approximately 2.51 acres of vernal pool habitat. (see IV.A.19(3) for more details.)

Mitigation-Related?: Yes.

Project Objectives: According to the Mitigation Agreement between Cobblestone and CDFG, the mitigation should establish self-sustaining populations of plants in approximately 2.97 acres of newly created habitat on the mitigation site. Self-sustaining is defined as approximately 13,000 individuals of *Lasthenia burkei* and 137,000 individuals of *Blennosperma bakeri* for 2 consecutive years without supplemental seeding.

Project Methods: The mitigation plan was devised by R. Osterling, Inc. (1989). The plan proposed to transplant all existing plants and/or seeds to a 20-acre receptor site located

approximately 1.5 miles west of the San Miguel Estates property, with existing 3.49 acres of vernal pool resources. Approximately 2.5 acres of vernal pool habitat will be constructed at the receptor site with pool configuration and depth based on survey of existing pools. Grading will be done with small equipment under supervision of a qualified botanist (Charlie Patterson, private consultant). Plant material will be "transferred." Seed will be collected from donor pools and the top 1-2 inches of pool bottom duff will be excavated and spread in the excavated pools at the receptor site. Monitoring will continue through June 1991.

Criteria for Success: None explicitly stated.

Project Success: Unknown. No information found in EPP files.

Date Project Initiated: March 1989.

IV.A.3. *Brodiaea filifolia* (Thread-leaved Brodiaea): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: "College Area Specific Plan in San Marcos." The Baldwin Company proposed a development on 530 acres of undeveloped land in the City of San Marcos, on a ridge behind the college. The onsite population of *Brodiaea filifolia* is part of the county's most extensive, known population.

According to the monitoring plan (WESTEC 1988), the mitigation plan included: (1) all onsite mitigation activities; (2) a 12-acre preserve that is completely fenced (vinyl-clad chain-link), protected for the life of the project; (3) planting of (presumably) local plants; (4) creation of a stable, relatively weed free *Brodiaea filifolia* population, requiring low maintenance; (5) onsite salvage of each plant species included in the preserve; (6) transportation and laying of suitable soils (Huerhuero Series); (7) maintenance during the first several years; and, (8) monitoring by a qualified botanist.

Mitigation-Related?: Yes.

Project Objectives: Two objectives were identified: (1) to set aside a 12-acre preserve for existing native grassland habitat supporting *B. filifolia*; and, (2) to reintroduce *Stipa pulchra* (purple needle grass) to disturbed portions of the preserve (ERC Environmental and Energy Services Co. 1990c).

Project Methods: During 1988, clay soils and 8167 *B. filifolia* corms were collected from a 25 ft^2 area within the original population and brought to the preserve. Five plots were marked and rabbit exclosures were installed. The largest corms collected were planted in planting holes in the test plots and throughout the preserve. Smaller corms were shipped to a contract nursery (Tree of Life Nursery, San Juan Capistrano) to be grown for increased size. A portion of these corms (870) were outplanted in the fall of 1990. Seed of *Brodiaea filifolia* also was collected from the original population and seedlings were grown at the nursery for two seasons. These were planted in the preserve in 1990 (ERC Environmental and Energy Co. 1990c).

Monitoring includes: (1) overall success; (2) role of corm size in relation to survivorship and flowering; (3) field establishment of nursery corms under controlled conditions with and without fertilizer treatments; (4) efficacy of relocating *B. filifolia* populations by soil importation; (5) role of supplemental irrigation in the establishment of transplanted corms; and, (6) use of field-collected seed and nursery-generated seedling corms in restoration (ERC Environmental and Energy Services Co. 1990c).

Criteria for Success: Criteria for success includes: (1) 75% survival rate of *Brodiaea filifolia* corms in test plots and 80% in the grassland; (2) 80% survival rate of *Stipa pulchra* plugs (seeds were planted similarly and an 80% survival rate was considered for this activity); (3) weeds should not cover the test plots dense enough to interfere with *Brodiaea filifolia* establishment and noxious weed species [undefined] should be eliminated from the preserve. The same criteria were considered for the *S. pulchra* plantings; (4) herbivory

damage assessed as above-ground and below-ground growth for *B. filifolia*. Acceptable damage to vegetative material is 10% or less of all plantings. Gopher damage to corms cannot exceed 5% in any one plot or 20% overall; and, (5) acceptable herbivory losses for *S. pulchra* should not exceed 10%. No criteria were established for reproductive success, "offset" production of corms, or soil importation.

Project Success: Project is in-progress and will continue until December 1993. To date, preliminary results of the monitoring efforts indicate that the introduction of *Brodiaea filifolia* corms has been largely successful. Corm growth increased significantly between 1989 and 1990. Eighty-seven percent (87%) of the corms have remained viable and 19.9% have produced "offsets." Also, fertilizer treatments of corms grown in the nursery did not improve vegetative development. Irrigation showed initial signs of promise in improvement of establishment of corms, particularly with soil importation. At the time of the monitoring report, results were not available for assessing the success of the transplanted nursery-grown corms. Direct seeding was not successful, in either the irrigated or non-irrigated seed locations. Why it was not successful is not known, but it may be possible that the seeds were held in storage too long and lost viability.

The 1989 planting of *Stipa pulchra* plugs was not successful due to the late planting in conjunction with very warm weather and drought. A portion of the plugs was replaced in winter 1990, and an additional experimental plot was installed in 1990 to test the effects of supplemental irrigation on *S. pulchra* establishment. Significantly more plants survived than those grown from seed (94.8% *vs.* 61.6%).

Efforts to eliminate sweet fennel (*Foeniculum vulgare*) and cardoon (*Cynara cardunculus*) have largely been successful, although mustard (*Brassica* [*nigra?*]), wild radish (*Raphanus sativus*), and invasive annual grasses are not controlled.

Herbivory on *Brodiaea filifolia* by rabbits does not appear to be a problem, although there appears to be some disturbance by gophers within as well as outside the

exclosures (ERC Environmental and Energy Services Co. 1990c).

Date Project Initiated: May 1988.

IV.A.4. ***Brodiaea insignis*** (Kaweah Brodiaea): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Mr. John Stebbins, Fresno.

Project Name and Description: "Kaweah Reservoir Dam Expansion" (Tulare County), initiated by the California Department of Water Resources. Project plans are being drafted at this time.

Mitigation-Related?: Yes.

Project Objectives: Project plans are being drafted at this time. Net yet available.

Project Methods: Project plans are being drafted at this time. Net yet available.

Criteria for Success: Project plans are being drafted at this time. Net yet available.

Project Success: Net yet available.

Date Project Initiated: 1989.

IV.A.5. ***Calochortus greenei*** (Greene's Mariposa Lily): Not state listed; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. William Ferlatte, Siskiyou County Dept. Agriculture and Ms. Barbara Williams, U.S. Forest Service, Klamath National Forest.

Project Name and Description: None. *Calochortus greenei* is not a state-listed species, and both respondents answered briefly. Project involved a road widening/construction project that required two mitigation transplantation efforts.

Mitigation-Related?: Yes.

Project Objectives: None stated.

Project Methods: None stated, but presumably the bulbs were dug by hand and transported

to the mitigation sites and replanted there.

Criteria for Success: None stated.

Project Success: Approximately 65 plants/bulbs were transplanted on May 23, 1989. As of May 9, 1990 [sic] (June 1989?), approximately 10 individuals survived the transplantation onto U.S. Bureau of Land Management and private property. This resulted in a survivorship rate of approximately 15%.

Date Project Initiated: May 1989.

IV.A.6. *Chorizanthe howellii* (Howell's Spineflower): State threatened; Federal Candidate C2; CNPS List 1B.

Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento.

Project Name and Description: None. Project involved the reintroduction of *Chorizanthe howellii* and *Erysimum menziesii* to archeological sites at MacKerricher State Park (Mendocino County) after an archeological dig. The site is a coastal dune ecosystem. University of California, Davis, initiated an archeological dig in 1989-90 at sites containing rare species. (see IV.A.13(1) for more details).

Mitigation-Related?: Yes.

Project Objectives: None stated.

Project Methods: Seed was collected in the summer of 1989 from the plants on site before the archeological dig was initiated. Plug plants were grown at the California Conservation Corps (CCC) Napa nursery and outplanted in February 1990 by the CCC. Plants were monitored by an undescribed photo monitoring technique. Outplanted plants also were counted and mapped. Initial costs for the project were: (1) salary $800.00; (2) travel $400.00; and, (3) plants $200.00, for a total of $1400.00.

Criteria for Success: None stated.

Project Success: Project on-going. Information not yet available.

Date Project Initiated: July 1989.

IV.A.7. *Cirsium occidentale* var. *compactum* (Compact Cobweb Thistle): Not State listed; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. Gary Ruggerone, California Department of Transportation, San Luis Obispo.

Project Name and Description: California Department of Transportation is involved in two projects, "Little Pico Bridge Replacement" and "Piedras Blancas Shoulder Widening." The former is on-going, and the latter was conducted in 1986. Both projects are along Highway 1 in San Luis Obispo County on ocean bluffs. *Cirsium occidentale* var. *compactum* is found along the disturbed highway shoulders.

Mitigation-Related?: Yes. However, neither project included CEQA permit conditions regarding transplantation of *Cirsium occidentale* var. *compactum*, although California Department of Transportation consulted with the USFWS.

Project Objectives: Transplantation and reseeding of the disturbed areas with *Circium occidentale* var. *compactum* to maintain populations.

Project Methods: Plants of various ages were removed from the impact area and were transplanted to immediately adjacent areas in January and February (1987?). Seed was collected in July through October (1986?), scarified, and scattered in January and February (1987?).

Both sites are monitored several times per year until it can be determined whether a reproducing population has been established. Neither site has received long-term protection, although the areas are considered by Caltrans as "environmental sensitive areas." Costs of the projects have been absorbed in the overhead. No reports other than brief field notes of the transplantation were filed.

Criteria for Success: Success was defined as survival of transplants and germination of seed for reintroduction to establish a continued presence of *Cirsium occidentale* var. *compactum* in the area.

Project Success: For Piedras Blancas, there was only partial success. Transplanting was a total failure, but the respondent reported some success with reseeding. For Little Pico, the transplantation was a failure. Seeding has not yet been initiated.

Date Project Initiated: 1986.

IV.A.8. *Croton wigginsii* (Wiggin's Croton): State rare; Federal Candidate C3C; CNPS List 2.

Respondent: Mr. Gerald Hillier, U.S. Bureau of Land Management, Riverside.

Project Name and Description: None. Project involved the construction of a new campsite ("Gecko") at the Imperial Sand Dunes, immediately south of Highway 78 (Imperial County).

Mitigation-Related?: Yes.

Project Objectives: Objectives were to establish seedings of *Croton wigginsii* in an adjacent Wilderness Study Area (WSA).

Project Methods: Seedlings were dug with a shovel of sand, and then placed in a bucket of wet sand. The buckets were transported approximately 1 mile away to a WSA site on the north side of Highway 78. A slice with a shovel was made in the new substrate, and the seedlings were transplanted in approximately 5 per group. About 12 groups were established.

The seedlings were visited approximately every three days for two weeks to monitor the success of the transplantation. During that two-week period, all the seedlings died.

Criteria for Success: Not clearly stated. Respondent suggested that the criterion was

successful establishment of transplanted seedlings.

Project Success: Respondent considered that the project was successful because it established whether transplantation of *C. wigginsii* seedlings would be a viable option. However, as stated above, none of the seedlings survived and therefore, it should not be considered successful from a biological viewpoint.

Date Project Initiated: Unknown.

IV.A.9. ***Eriastrum densifolium* ssp. *sanctorum*** (Santa Ana River Woollystar): State endangered; Federal endangered; CNPS List 1B.

Respondent: Mr. Craig Martz, Associate Environmental Planner, California Department of Transportation, Sacramento, and data obtained from EPP files.

Project Name and Description: "Santa Ana River Woollystar Relocation Project." California Department of Transportation (Caltrans) attempted to change State Route 30 in San Bernadino County. The project included freeway construction along State Route 30, and a second phase of construction between Interstate 10 in Redlands and Fifth Street in the City of San Bernadino. Grading in the second phase would have resulted in the loss of approximately 1.24 acres of alluvial scrubland, habitat for 1039 individuals of *Eriastrum densifolium* ssp. *sanctorum*. However, the project was modified to affect only 733 individuals, with the remaining 308 individuals preserved in a designated environmental sensitive area avoided during the construction phase. The area is to be protected in perpetuity once construction is completed.

Mitigation-Related?: Yes.

Project Objectives: None stated specifically, but the overall objective appears to be the successful establishment of transplanted individuals of *Eriastrum densifolium* ssp. *sanctorum* from along State Route 30 in the Santa Ana River Wash to three transplant receptor areas within the right-of-way.

Project Methods: A contractor (Nativescapes) was hired to transplant 733 individuals of *E. densifolium* ssp. *sanctorum* from the west side of the Highway 30 project site to three locations on the east side of the highway; during January through March 1988. Plants were removed with a Vermeer TS-20 tree spade mounted on a Bobcat tractor. Plants were then fitted into burlap-lined mesh baskets that conformed to the rootballs for transport to the recipient areas. Individuals were planted in rows within each of the three transplant areas. Each row as initially marked with a wooden stake that was labeled with the number of individuals in the row. However, this labeling method was deemed inadequate in the second year of monitoring. Transplants were then marked individually with aluminum tags. Monitoring of the transplants is to be conducted for three years following the transplantation.

Criteria for Success: None stated explicitly.

Project Success: Respondent felt that the project had not achieved the level of success that was hoped for, in part because of the current drought conditions. After the first year of monitoring, Transplant Area 1 suffered a 39% mortality, Transplant Area 2 suffered a 56% mortality, and Transplant Area 3 suffered a 48% mortality of transplants. Most of the mortality in the first year was attributed to transplant shock, although natural mortality and competition may also be responsible in part (Martz 1990). The first year monitoring report suggests that the transplantation project was "highly successful thus far" because of relatively high survivability (61%, 44%, and 52% in Areas 1, 2, and 3, respectively), and good seedling production was observed.

Results of the May 1990 monitoring (Martz 1990) indicate a survival rate of 46.7% in Transplant Area 1, 38.9% in Transplant Area 2, and 40.5% in Transplant Area 3. The overall survival for the three areas was 332 individuals (44.2%). Approximately 85.5 percent of the surviving individuals were reproductive; however, 31 individuals (9.3%) were considered to be in obvious decline.

Seedling recruitment in the three Transplant Areas numbered 783, 80, and 339, respectively. Martz figured that seedling production in the three areas totalled 3.6 seedlings per Transplant Area 1, 3.3 seedlings per Transplant Area 2, and 5.7 seedlings per Transplant Area 3. However he also suggested that native *Eriastrum* plants already existing in Areas 2 and 3 may have contributed to these totals.

Date Project Initiated: January 1988.

IV.A.10. ***Eriophyllum mohavense*** (Barstow Woolly Sunflower): Not State listed; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. James Brownell, California Energy Commission, Sacramento.

Project Name and Description: "Luz SEGS VII." The project involved the construction in 1988 of a solar power plant by the California Energy Commission, at Kramer Junction in San Bernardino County (Mojave Desert). Luz Engineering, the company that was contracted to construct the power plant, attempted to salvage the plant by collecting seed, topsoil, and additional subsoil material, and by depositing these on the receptor site.

The original occurrence of more than 1700 individuals of *Eriophyllum mohavense* on less than 2 acres represented the western-most location of the species, which is one of the main reasons for attempts to preserve this site. The site is also unusual because population densities are much higher here than in other regions where *Eriophyllum mohavense* is found. Also, a soil investigation was conducted by ERT (1988a; Fort Collins, Colorado) to determine whether the distribution of *Eriophyllum mohavense* (and the Mojave spineflower [*Chorizanthe spinosa*]) is controlled by edaphic factors. The report established that there are distinct differences between the soils on the low knolls that support *Eriophyllum mohavense* and adjacent areas that do not. The rare plants apparently grow on areas with a near surface layer (Btn natric horizon) and an underlying "pan" layer (the lower portion of the natric horizon, the Btkn horizon) that are both highly alkaline.

These layers apparently restrict rooting and establishment by spiny saltbush and other common shrubs of the area, but are not restrictive to *Eriophyllum mohavense* that roots above the pan (ERT 1988a). ERT also found very high levels of boron in the soil. This information was used in selection of the receptor site of *Eriophyllum mohavense*.

Mitigation-Related?: Yes.

Project Objectives: The state objective was to re-establish a population of *Eriophyllum mohavense* on a nearby artificially constructed hill. The original location of *Eriophyllum mohavense* was destroyed by the construction of the solar power plant.

Project Methods: According to the biological resources mitigation implementation plan (ERT 1988b), the consulting botanist worked with Mr. Mark Bagley of Bishop, California, to collect surface material (seed, litter, and the top 0.5 inch of topsoil) within a delineated area at the impacted site. This was done to be done with flat-bottomed shovels and other hand tools. The collected material was to be stored temporarily by spreading it on plastic sheets near the relocation site. About 25 percent of the seed source material was to be used to provide supplemental seed to areas of known habitat for *Eriophyllum mohavense*.

Soil was salvaged in three steps after seed collection. The base material was to be applied to the existing surface at the relocation site to increase the southerly aspect of the site to an approximately 4 percent slope. Following application of the base material, more soil was to be placed on the relocation site, spread, and contoured. In the last stage, the seed source was to be applied and raked smooth. The site was to be misted with water to moisten the seed material and help bind it to aid in erosion control. Finally, the relocation site was fenced by the Luz Engineering Corporation to prohibit future disturbance (ERT 1988b).

Criteria for Success: No specific success criteria were established. Respondent reported that the general criteria was to find the species on the relocation site.

Project Success: Respondents claims that at the present time, due to the unusually dry

years since this project has occurred, no systematic monitoring has been conducted and no plants have been found. However, they claim that the success is "uncertain" until the desert receives normal rainfall.

Date Project Initiated: 1988.

IV.A.11. *Eryngium aristulatum* var. *parishii* (San Diego Button Celery): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Drs. C.H. Black and Paul Zedler, Dept. Biology, San Diego State University.

Project Name and Description: "Caltrans Del Mar Mesa Vernal Pools" and "U.S. Navy North Miramar Project Mitigation." As background, California Department of Transportation (Caltrans) had two major projects on Kearny Mesa that eliminated vernal pools. The first project was mitigated by the purchase of 26 acres of prime vernal pool habitat on Del Mar Mesa and a second acquisition of an additional 52 acres at Del Mar Mesa. This second acquisition was to be used in an experiment to create artificial pools capable of supporting *Eryngium aristulatum* var. *parishii* and *Pogogyne abramsii* (Zedler and Black 1988). Respondents did not explain the Mirimar Project. (see IV.A.29 for additional information).

Mitigation-Related?: Yes.

Project Objectives: For both projects, the objective was to create vernal pool habitat for *Eryngium aristulatum* var. *parishii* and *Pogogyne abramsii*.

Project Methods: A set of 40 artificial basins was excavated in December 1986, and 387 were inoculated with material collected from the natural pools on Del Mar Mesa.

Criteria for Success: Respondents did not specifically designate criteria for success.

Project Success: Respondents feel that the projects are "not yet" successful because the rare species have not attained population densities found in the natural pools.

Date Project Initiated: December 1986.

IV.A.12. *Erysimum capitatum* var. *angustatum* (Contra Costa Wallflower): State endangered; Federally endangered; CNPS List 1B.

Respondent: Ms. Joy Albertson, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex.

Project Name and Description: "Vaca Dixon-Contra Costa 230-kV Reconductoring Project: Habitat Protection and Enhancement for Antioch Dunes." Pacific Gas and Electric Company (PG&E) reconductored the San Joaquin River crossing of the Vaca Dixon-Contra Costa 230 kV transmission line in the fall of 1988. The project took place specifically on the Sardis Unit of the Antioch Dunes National Wildlife Refuge (ADNWR), east of the town of Antioch. USFWS personnel conducted a Section 7 consultation with PG&E before granting access permit. (see IV.A.25 for more details.)

Mitigation Related?: Yes.

Project Objectives: Objectives were: (1) protection of habitat from future damage caused by construction/repair activities; (2) transplantation of sensitive species from the access corridor to allow vehicle access to the tower; (3) establishment of new subpopulations of *Erysimum capitatum* var. *angustatum* (and *Oenothera deltoides* ssp. *howellii*); (4) enhancement of existing populations; and, (5) determination of whether direct seeding or transplantation of nursery liners is preferable transplantation technique.

Project Methods: Eighteen wallflowers from the PG&E east parcel access corridor were transplanted either to other locations on the parcel or to the Sardis Pit area. A small circular area was first cleared of all vegetation, then an appropriate sized hole was dug. A plant was placed in the hole and dirt was packed firmly around it. Nursery grown plants were planted in a similar manner in pre-selected sites on the PG&E and Sardis Pit parcels.

Three hundred seventy-seven (377) wallflower seedlings were planted in January

1990. A survey the following March provided a count of 364 surviving seedlings (96.6%) survival. Plants were monitored during the first spring and summer to determine whether additional water or weeding was needed so as to assure adequate survival. A final evaluation of survival will be made in the spring of the second year.

Cost of the nursery-grown seedlings was estimated at $0.30/seedling; 377 seedlings produced; therefore it cost $113.10.

Criteria for Success: The replacement of the plants that were destroyed by the construction, specifically 230 *E. capitatum* var. *angustatum* seedlings and 160 *O. deltoides* ssp. *howellii* seedlings was the criterion.

Project Success: Respondent felt that the project was partially successful. Transplantation of the wall flowers resulted in aa final 61.1% survival rate for 18 of the 22 plants, and 0.0% survival of the additional four (4) individuals. However, germination was high and survival of outplanted seedlings was 96.6% in the first year.

Date Project Initiated: April 5, 1989, for transplantation of *E. capitatum* var. *angustatum* individuals; January 1990 for seedling outplanting.

IV.A.13. ***Erysimum menziesii*** (Menzies' Wallflower): State endangered; Federal Candidate C1; CNPS List 1B.

1) Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento.

Project Name and Description: None. Project involved the reintroduction of *Erysimum menziesii* and *Chorizanthe howellii* to archeological sites at MacKerricher State Park (Mendocino County) after an archeological dig. University of California, Davis, initiated an archeological dig in 1989-90 at sites containing rare species. (see IV.A.6 for more details.)

Mitigation-Related?: Yes.

Project Objectives: None stated.

Project Methods: Seed was collected in the summer of 1989 from the plants on site before the archeological dig was initiated. Plug plants were grown at the California Conservation Corps (CCC) Napa nursery and outplanted in February 1990 by the CCC. Plants were monitored by an undescribed photo monitoring technique. Outplanted plants also were counted and mapped. Initial costs for the project were: (1) salary $800.00; (2) travel $400.00; and, (3) plants $200.00, for a total of $1400.00.

Criteria for Success: None stated.

Project Success: Project on-going. Information not yet available.

Date Project Initiated: July 1989.

2) Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento, and data obtained from EPP files.

Project Name and Description: "Spanish Bay." Project involved the reintroduction of *Erysimum menziesii*, *Lupinus tidestromii* var. *tidestromii*, and *Gilia tenuiflora* ssp. *arenaria* to the dunes surrounding the Links at Spanish Bay (Monterey County). (see IV.A.15 and IV.A.22 for more details.)

Mitigation-Related?: Yes.

Project Objectives: To increase the numbers of the three rare plant species and either enhance existing populations or create new stands.

Project Methods: Seed was collected from a population at Asilomar and propagated at Spanish Bay Nursery. Outplanting of seedlings was to occur during the winter rainy season. The populations were to be fenced and signed, and a boardwalk constructed to route foot traffic past the outplantings. Regular maintenance is to include weeding of invasive species.

Criteria for Success: Survivorship of 80% for the total outplanted seedlings in the first

year, and a total of 70% of the plants within each distinct outplanting site. Should survivorship fall below these standards, replanting would be required to occur during the next rainy season.

Project Success: Respondent reports that the project appears successful, although no information held in the EPP files confirmed this.

Date Project Initiated: 1987.

3) Respondent: Dr. John Sawyer, Department of Biology, Humbolt State University, Arcata.

Project Name and Description: None. Project involved a three-year research project to study the biology of *Erysimum menziesii* and mitigation techniques. The research was supported by a timber company to mitigate the impacts of their harvest operation.

Mitigation-Related?: Yes.

Project Objectives: Stated objectives were to determined a viable population size and ways of habitat restoration to achieve a viable population size.

Project Methods: The current research project has not included any transplantation, relocation or reintroduction at this date. However, 30 permanent plots in existing populations are monitored quarterly, and have been so for the last two and one-half years. Project costs were given at $650,000.00.

Criteria for Success: Criterion was stated somewhat vaguely as when the existing population exceeds in size that projected by computer modeling.

Project Success: Project was still in progress at the time of the questionnaire.

Date Project Initiated: 1988 is the date given for the beginning of the project, although seed collection commenced in April of 1989.

IV.A.14. *Erysimum teretifolium* (Santa Cruz Wallflower): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: "Revegetation of the Olympia Quarry." The revegetation is to be done in compliance with conditions stipulated in a mining permit administered by Santa Cruz County. The Olympia Quarry is operated by Lone Star Industries, Inc., and is located west of Scotts Valley. The quarry site is approximately 200 acres, the majority of which has been mined for coarse sand for construction.

The adjacent vegetation is considered biologically significant because it is a xeric environment of sand hills in the midst of more mesic vegetation. Some of the rare elements on the quarry site include rare disjuncts or unusual flower color morphs.

Mitigation-Related?: Yes.

Project Objectives: The goal of the revegetation is to establish the Santa Cruz wallflower on the mined slopes and benches of the Olympia Quarry. In addition, a revegetation plan will attempt to recreate the native plant associations on the previously mined areas.

Project Methods: Larry Seeman and Associates, Inc. (LSA 1989) proposes to collected 50% of all the seed produced by a group of 300 plants growing in the eastern section of the quarry. The planting areas are composed of 15-ft wide benches at 60-ft intervals along a 1.5:1 slope. The seeding regime is to replicate the density of the *Erysimum teretifolium* in undisturbed communities.

Criteria for Success: Criteria will be developed by quantitatively sampling the vegetation in areas with *Erysimum teretifolium*.

Project Success: Project is not yet implemented. Information not yet available.

Date Project Initiated: Revegetation Plan initially submitted by LSA Associates, Inc. in July 1987 (LSA 1987, 1989). The project has not yet begun, however.

IV.A.15. *Gilia tenuiflora* ssp. *arenaria* (Sand Gilia): State threatened; Federal Candidate C1; CNPS List 1B.

Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento, and data obtained from EPP files.

Project Name and Description: "Spanish Bay." Project involved the reintroduction of *Erysimum menziesii*, *Lupinus tidestromii* var. *tidestromii*, and *Gilia tenuiflora* ssp. *arenaria* to the dunes surrounding the Links at Spanish Bay (Monterey County). (see IV.A.12(2) and IV.A.22 for more details.)

Mitigation-Related?: Yes.

Project Objectives: To increase the numbers of the three rare plant species and either enhance existing populations or create new stands.

Project Methods: Seed was collected from a population at Asilomar and propagated at Spanish Bay Nursery. Seeds of sand gilia need stratification and scarification with differing daylength and temperature regimes. Outplanting of seedlings was scheduled to occur during the winter rainy season. The populations were to be fenced and signed, and a boardwalk constructed to route foot traffic past the outplantings. Regular maintenance was to include weeding of invasive species.

Criteria for Success: Survivorship of 80% for the total outplanted seedlings in the first year, and a total of 70% of the plants within each distinct outplanting site. Survivorship was to be compared in outplanting sites with existing populations in an attempt to account for annual fluctuations that may be environmentally controlled. Should survivorship fall below these standards, replanting would be required to occur during the next rainy season.

Project Success: Respondent reports that the project appears successful, although no information in the EPP files confirmed this.

Date Project Initiated: 1987.

IV.A.16. *Hemizonia increscens* ssp. *villosa* (Gaviota Tarplant): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Mr. John Storrer, Storrer & Semonsen Environmental Services, Santa Barbara.

Project Name and Description: "Gaviota Interim Marine Terminal, Santa Barbara County, California." Mitigation was required for the construction of a secondary access road to the marine terminal.

Mitigation-Related?: Yes.

Project Objectives: The stated objective was the establishment of 5,800 ft^2 of *Hemizonia increscens villosa* habitat.

Project Methods: The impacted site was surveyed for *Hemizonia increscens* ssp. *villosa* and it was determined that approximately 50 individuals lay within the access road alignment. There are considerably more individuals found adjacent to the area (approximately 400-600 individuals). Seed was obtained from plants collected from the tank farm area prior to construction. An additional 2-3 inches of topsoil was retrieved before grading. More topsoil (3 inches) also was removed from the access road alignment during grading. The receptor site is on California Department of Parks and Recreation property east of the Texaco Interim Marine Terminal. No further site preparation was attempted prior to broadcasting of seed. The receptor site was fenced with three strands of barbless wire to delineate boundaries, and the project was signed.

Additional (approximately) 50 tarplant seedlings were discovered during an inspection of the site in March 1989. Adjacent weedy vegetation was clipped within a 6 inch radius of many of the plants to decrease competition.

Criteria for Success: Performance criteria included: (1) no evidence of soil erosion; and, (2) presence of a viable *H. increscens* ssp. *villosa* population. The latter was determined by comparing the density of flowering plants during the peak growing period with that of

the surrounding populations.

Project Success: An intensive survey was conducted on May 24, 1989, that recorded 136 flowering tarplants, with an additional nine plants that had died or seeded. The first year densitites of 1.2, 2.69 and 1.28 individuals per m^2 recorded were favorable in comparison with the Chevron restoration site. The project is on-going; however, the respondent felt that the first year's results were promising. More information is not yet available.

IV.A.17. ***Hemizonia minthornii*** (Santa Susana Tarplant): State rare; Federal Candidate C2; CNPS List 1B.

1) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Santa Susana Tarplant (*Hemizonia minthornii*) Mitigation Program 2." Las Virgenes Municipal Water District built a new water reservoir adjacent to its existing reservoir in the Twin Lakes area near Chatsworth. Mitigation for this project involved the salvaging of *Hemizonia minthornii* plants, and transplanting the salvaged plants and some nursery plants grown from seed on the 250 m^2 cut slopes surrounding the new reservoir.

Mitigation-Related?: Yes.

Project Objectives: The overall project objective was to establish a new population of Santa Susana tarplants on the cut slopes surrounding the new water reservoir.

Project Methods: The project site boundaries were staked prior to the initiation of the construction. Seeds were collected in the summer of 1988 at a time considered by the consultants as not phenologically optimum for success -- *i.e.*, while the plants were in full bloom. Individual plants were located in either rock crevices or on thin soil in open areas. A pick mattock was used to break up the sandstone crevices to remove the top portion of the root, but the root was very deeply embedded in the substrate and could not be removed without breaking.

Potting mix was brought to the site and mixed with clean sand and soil from the site. Each transplanted plant was trimmed with clippers to compensate for the loss of the root system, and then potted. Each transplant was watered several times before transportation to Tree of Life Nursery. Cuttings were taken from the transplants and retained for their inflorescences and to attempt root cuttings. A total of 55 plants were potted, representing approximately 70% of the mature plants within the impacted area. Approximately 50% survived the initial transplantation operation; however, cutting survival and seed germination were poor (McClelland Consultants (West), Inc. 1988). None of the initial seed sown germinated (McClelland Consultants (West), Inc. 1988). A second collection of seed made in October 1988 was germinated at Tree of Life Nursery to compensate for the losses.

As of February 1989, however, only 8 of the 55 transplants have survived. During 1990, the site was visited and monitored only 4 times, as the plants appeared to show signs of naturalizing to the cut slope.

Criteria for Success: Performance criteria included the following: (1) 15 surviving mature plants from the transplants by May 1989; (2) 50 seedlings by May 1989; (3) 10 mature plants flowering by October 1989; (4) 30 mature plants by October 1990; (5) 100 seedlings by October 1990; (6) 50 mature plants by October 1991; (7) 70 mature plants with ground coverage of about 25 m^2 by October 1992 (McClelland Consultants (West) 1988).

Project Success: The project success has not been evaluated only because the project technically is still on-going. However, the survival of 8 of the 55 transplants, only 7 of which are doing well, is rather poor (McClelland Consultants (West) 19908). The project has been rather controversial (see article in the Los Angeles Times, February 3, 1989, p. 3, 14).

Date Project Initiated: July 1988 for the initial collection of seed and excavation of plants in the impacted area; January 1989 for the transplantation of salvaged plants.

2) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Woolsey Canyon Development." Chateau Builders proposed in 1989 to construct an extensive residential community in Woolsey Canyon, western Los Angeles County. The project site is located in a sensitive ecological areas as designated by Los Angeles County. An environmental assessment performed by Michael Brandman & Associates (November 1988) identified that the proposed project would result in the direct loss of approximately 57 individuals of *Hemizonia minthornii*, in a population of approximately 147 individuals.

Mitigation-Related?: Yes.

Project Objectives: The primary objective of the mitigation plan will be: (1) to establish on the development site, a second population of *Hemizonia minthornii*, using propagules derived from individuals in the original population that is impacted by the development. The new population should be capable of natural regeneration over the long term; (2) offset of the loss of approximately 57 individuals of *Hemizonii minthornii* with the introduction of approximately 150 individuals as a founder group in a new population; and, (3) advance the state of knowledge of *Hemizonii minthornii* by carrying out appropriate research-related activities in conjunction with mitigation activities (Mistretta 1989).

Project Methods: The plants occur within a single population on a sandstone outcrop on the project site. The original development plan was designed to include 90 individuals in a reserve that would be bordered by the development. However, after consultation with CDFG, the reserve site was reconfigured to be continuous with an adjacent natural area on the southern boundary of the project, rather than being an island within the development (Mistretta 1989).

The Rancho Santa Ana Botanic Garden (RSABG) has been retained by the Chateau Group to advise on the horticultural and research-related aspects of the program. Data to be

gathered are: (1) number of individuals on site; (2) soil analyses; (3) population statistics; (4) reproductive capacity; (5) genetic composition; and, (6) floristic composition of the community.

The proposed revegetation program indicates that prior to the commencement of construction, the preserve site will be fenced and left undisturbed. The remaining Santa Susana tarplants will have the infructescences removed by hand at the appropriate season. Additional seed collection will be done if deemed necessary. Collected seed will be cleaned and dried prior to storage.

Half the collected seed will be sown in the preserve after the transplantation of salvaged individuals (see below). The remaining half will be propagated at RSABG for seedling transplantation.

In addition, the mature plants in the impacted area will be salvaged by digging with a shovel and pick mattock to a depth of 1 ft. Plants will be placed in planters for temporary off-site storage. Plants will be trimmed and watered 3 times during the first week and weekly thereafter until transplanted.

Transplant receptor sites within the preserve will be selected by a botanist/horticulturalist. Plants will be planted without mulch or fertilizers, and watered weekly for 4 weeks. The project site will be checked monthly by the botanist/horticulturalist for an undetermined period.

IV.A.18. *Holocarpha macradenia* (Santa Cruz Tarplant): State endangered; Federal Candidate C1; CNPS List 1B.

1) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Hilltop Commons Development." The Nylen Company, Inc., developed an apartment complex in Pinole, Contra Costa County. Dr. Neil Havlik, then of the East Bay Regional Park District, agreed to perform a salvage of the mature

individuals of *Holocarpha macradenia* from the project site and transplant them to a nearby park within the East Bay Regional Park District.

Mitigation-Related?: Yes.

Project Objectives: None specifically stated, but the project was designed to salvage the mature plants of *Holocarpha macradenia* from a housing development site in Pinole, and subsequently establish a new population of *H. macradenia* at Wildcat Canyon Regional Park.

Project Methods: Pallets of soil, 4 ft^2 by 1 ft deep, containing *Holocarpha macradenia* plants were dug and seed was collected from these plants. Seed from the salvage was taken by Dr. Havlik and spread as an enlargement of several existing populations in Wildcat Canyon Park (Havlik's Stand Nos. 2, 11, 12, 13, 14, 15; [CNDDB Occ. Nos. 2, 29, 31 for the first three locations]). Seed also was spread at a site in Sather Canyon on the east side of San Pablo Reservoir.

Criteria for Success: None stated.

Project Success: Havlik monitored 21 populations, 7 of which were new populations, and reported an increase of 30% of the individuals from 1985 to 1986[10].

Date Project Initiated: September 13, 1986.

IV.A.19. *Lasthenia burkei* (Burke's Goldfields): State endangered; Federal Candidate C2; CNPS List 1B[11].

1) Respondent: Mr. Charlie Patterson, Plant Ecologist, private consultant, El Cerrito, and

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[10]See letter to Ms. Susan Cochrane, [formerly] Endangered Plant Coordinator, from Dr. N. Havlik, [formerly of the] East Bay Regional Park District, dated March 9, 1987.

[11]Mr. Ken Milam, Sonoma County Planning Director, returned a questionnaire for *Lasthenia burkei*, but the information provided was so vague as to be useless for this analysis. Therefore, the questionnaire is not included.

data obtained from EPP files.

Project Name and Description: " Airport Boulevard Business Park." A business park was constructed in 1984, located just northeast of the Sonoma County Airport.

Mitigation-Related?: Yes.

Project Objectives: The stated objective for the mitigation for the business park was the replacement of 0.3 acres of wetlands and pre-existing 5000 individuals of *Lasthenia burkei* with, at minimum, 10,000 individuals.

Project Methods: Seed was collected in 1984. Small pools were created by hand, clearing vegetation and topsoil in low swales within an 100 ft easement. These pools were seeded during the winter of 1985-1986. However, much of the easement was disturbed by the installation of a large storm drain before the seeding trials could be assessed. However, new larger pools were created later by a bulldozer-mounted blade during the fall of 1986, and seeded that year.

Criteria for Success: Essentially the replacement of a self-sustaining colony of *Lasthenia burkei* was the criterion for success.

Project Success: Respondent felt that the project was successful. The mitigated seeded population increased from no *Lasthenia burkei* to >6000 individuals in three years. However, due to additional complications, the pools were "re-worked" (*i.e.*, enlarged, re-contoured and re-seeded). The current year's results show in excess of 10,000 individuals.

2) Respondent: Mr. Charlie Patterson, Plant Ecologist, private consultant, El Cerrito, and data obtained from EPP files.

Project Name and Description: "Sonoma County Airport". This project involved the contruction of a new, paved apron at the Sonoma County Airport in 1986.

Mitigation-Related?: Yes.

Project Objectives: Objectives stated by the respondent for the airport expansion project was the replacement of the colony of *Lasthenia burkei* lost during construction.

Project Methods: Eleven small artificial pools were created by shovel and hoe in a broad, nearly level portion of the infield between the north end of Runway 14 and Taxiway Y. Pools were made by selecting a low spot and then scraping 1 to 6 inches of the surface. The scraped soil was piled into small berms around the downslope edges of the pools. Pools were seeded the day of construction.

Seed was sown both as seed collected in 1985 and from other existing populations 0.5 miles away, and by spreading the scraped topsoil from nearby colonies. These were then left alone for most of the winter and spring. Pools were monitored, which involved checking them for water collection and holding capacity, *Lasthenia burkei* germination, phenology, and reproduction.

Criteria for Success: Essentially the replacement of a self-sustaining colony of *Lasthenia burkei* was the criterion for success.

Project Success: Respondent felt that the project was successful. Seeded areas of existing ditches now support several thousand individuals of *Lasthenia burkei*, and another several thousand are growing in the constructed pools.

3) Respondent: Carl Wilcox, California Department of Fish and Game, Yountville, and data obtained from EPP files.None. Data obtained from EPP files.

Project Name and Description: "Santa Rosa Rare Plants Mitigation Plan San Miguel Estates 1." In 1989 Cobblestone Development Corporation proposed the development of San Miguel Rancho Subdivision (RSM) at 2001 Waltzer Road within the city of Santa Rosa, Sonoma County and San Miguel Estates No. 2 (SME) at 2192 Francisco Avenue, also within Santa Rosa. The SME project is an on-going housing construction and the RSM housing project was a 1989 development. The projects would destroy approximately

2.51 acres of vernal pool habitat. (see IV.A.2(2) for more details.)

Mitigation-Related?: Yes.

Project Objectives: According to the Mitigation Agreement between Cobblestone and CDFG, the mitigation should establish self-sustaining populations of plants in approximately 2.97 acres of newly created habitat on the mitigation site. Self-sustaining is defined as approximately 13,000 individuals of *Lasthenia burkei* and 137,000 individuals of *Blennosperma bakeri* for 2 consecutive years without supplemental seeding.

Project Methods: The mitigation plan was devised by R. Osterling, Inc. (1989). The plan proposed to transplant all existing plants and/or seeds to a 20-acre receptor site located approximately 1.5 miles west of the San Miguel Estates property, with existing 3.49 acres of vernal pool resources. Approximately 2.5 acres of vernal pool habitat will be constructed at the receptor site with pool configuration and depth based on survey of existing pools. Grading will be done with small equipment under supervision of a qualified botanist (Charlie Patterson, private consultant). Plant material will be "transferred." Seed will be collected from donor pools and the top 1-2 inches of pool bottom duff will be excavated and spread in the excavated pools at the receptor site. Monitoring will continue through June 1991.

Criteria for Success: None explicitly stated.

Project Success: Respondent indicated that although it was too early to tell because the projects are only in their first year, "[e]arly indications are that they will be the most successful relocations yet achieved in the Santa Rosa Area."

Date Project Initiated: March 1989.

4) Respondent: WESCO, Novato.

Project Name and Description: "County of Sonoma Public Service Area 31 Waste Water Storage Pond." The project involved the creation of a wastewater storage pond in 1988 on

approximately 3.7 acres of northern vernal pool, seasonal marsh and intermittent stream habitat (and 10 acres of non-native grassland). *Lasthenia burkei* was transplanted to an area known as "The Wildflower Preserve" on the Sonoma County Airport. The receptor site is already protected as part of the Sonoma County Airport mitigation.

Mitigation-Related?: Yes.

Project Objectives: The project objective was to create 4.4 acres of seasonal wetland habitat and to provide a transplantation site for *Lasthenia burkei.*

Project Methods: Seed was collected from plants at the impacted site. Plants in bloom were salvaged, kept in containers until seeded and seed subsequently was collected to be sown at the mitigation site. Topsoil was salvaged from around the plants to spread at the new sites.

The number of individuals are to be counted for each of five years.

Criteria for Success: Criteria have not been established.

Project Success: "Although the criteria have not been established, we feel that, for at least the first year of monitoring, the transplantation was somewhat successful. . . . Of course, long term viability of the population is still questionable." Approximately 1000 individuals were observed at the mitigation site, while only 150 plants were found at the impacted site.

Date Project Initiated: 1988.

IV.A.20. ***Lilaeopsis masonii*** (Mason's Lilaeopsis): State rare; Federal Candidate C2; CNPS List 1B.

1) Respondent: Mr. Niall McCarten, Department of Integrative Biology, University of California, Berkeley, and Department of Water Resources (DWR), Sacramento (questionnaire unsigned).

Project Name and Description: "California Department of Water Resources (DWR) Barker Slough Bank Revetment." The project was initiated in 1989 by DWR for levee bank

protection on private property. Individuals of *Lilaeopsis masonii* were transplanted from the east side of the slough to the west side.

Mitigation-Related?: Yes.

Project Objectives: Project objectives were the removal of *Lilaeopsis masonii* from the proposed rip-rap site and the transplantation of individuals to suitable habitat.

Project Methods: Populations of *Lilaeopsis masonii* were removed with a shovel, placed in shallow water in plastic containers and then placed in a boat and transported to the potential habitat (receptor site). After placing the transplant into the new site, the surrounding substrate was pressed along the edges to homogenize the substrate.

Eighteen (18) 50 x 50 cm permanent plots were established, and marked with numbered, color-coded metal stakes (ECOS, Inc. 1988). Control populations were marked similarly. All plants were to be counted in each plot five times during the first two years following transplantation, and three times per year for the following three years.

The receptor site initially was not protected, but due to the biological values of the site, it was purchased by CDFG as a preserve in January 1990.

Criteria for Success: Specific criterion was the survival of 80% or better of the individuals transplanted over a 5-year monitoring period.

Project Success: Unknown, as the project is on-going. One year of raw data is available from Mr. David Brown, DWR. DWR respondent claims that it is too early to make a determination as to whether the project is successful.

Date Project Initiated: April 1989

2) Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento.

Project Name and Description: None. Project is being considered; may involve the transplantation of *Lilaeopsis masonii* at Brannan Island State Recreational Area near Rio

Vista (Contra Costa County).

Mitigation-Related?: Yes.

Project Objectives: Project still being planned. None stated.

Project Methods: Project still being planned. None stated.

Criteria for Success: Project still being planned. None Stated.

Project Success: Project still being planned. Not applicable.

Date Project Initiated: Not yet initiated.

IV.A.21. *Lupinus milo-bakeri* (Milo Baker's Lupine): State threatened; Federal Candidate C2; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: None. In 1985, California Department of Transportation (Caltrans) performed road maintenance along State Highway 162 (Mendocino Pass Road) near the city of Covelo (Mendocino County). The mitigation project was to offset the impacts of this activity.

Mitigation-Related?: Yes.

Project Objectives: None stated explicitly, but the project was to establish several new populations to offset the loss of *L. milo-bakeri* during highway maintenance.

Project Methods: Caltrans collected seed from the CNDDB occurrence #2 for *Lupinus milo-bakeri* from August through September 1985. Not more than 15% of the population's annual seed crop was collected. Prior to seeding, the collected seed was rinsed, and the seed beds prepared by adding topsoil from the parent population. In October 1985, Caltrans planted the seed in areas of suitable habitat along Highway 162 between post mile markers (PM) 31.50 and 31.61, and from PM 32.00 to 32.14, as well as planted seed in suitable habitat near the Caltrans equipment yard near Covelo.

Criteria for Success: None stated.

Project Success: In some of the plots, there was considerable competition from annual grasses. Caltrans annually sprays the highway edges with herbicide, and this added to the growth of *L. milo-bakeri* in the seeded areas.

Date Project Initiated: August 1985.

IV.A.22. *Lupinus tidestromii* var. *tidestromii* (Tidestrom's Lupine): State endangered; Federal Candidate 1; CNPS List 1B.

Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento, and data obtained from EPP files.

Project Name and Description: "Spanish Bay." Project involved the reintroduction of *Lupinus tidestromii* var. *tidestronii*, *Erysimum menziesii*, and *Gilia tenuiflora* ssp. *arenaria* to the dunes surrounding the Links at Spanish Bay (Monterey County). (see IV.A.13(2) and IV.A.15 for additional details)

Mitigation-Related?: Yes.

Project Objectives: To increase the numbers of the three rare plant species and either enhance existing populations or create new stands.

Project Methods: Seed was collected from a population at Asilomar and propagated at Spanish Bay Nursery. Seeds of *Lupinus tidestromii* var. *tidestromii* need stratification and scarification with differing daylength and temperature regimes. Outplanting of seedlings was to occur during the winter rainy season. The populations were to be fenced and signed, and a boardwalk constructed to route foot traffic past the outplantings. Regular maintenance was to include weeding of invasive species. Monitoring will continue until 1993.

Criteria for Success: Survivorship of 80% for the total outplanted seedlings in the first year, and a total of 70% of the plants within each distinct outplanting site. Should survivorship fall below these standards, replanting would be required to occur during the

next rainy season.

Project Success: Respondent reports that the project appears successful, although no information in the EPP files confirmed this.

Date Project Initiated: 1987.

IV.A.23. *Mahonia nevinii* (Nevin's Barberry): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: None. The RANPAC Corporation proposed the construction of Vesting Tentative Tract No. 23267 that would impact a population of *Mahonia nevinii* on the Old Vail Ranch property. Although 12 plants are found on the property, the mitigation project involved the relocation of a single plant.

Mitigation-Related?: Yes.

Project Objectives: None stated explicitly.

Project Methods: The impacted plant would undergo crown division and root cuttings. These would be transplanted in the late fall (no more details were provided). The success of the transplantations would be monitored for three years following transplantation. Seed was to be collected in the summer of 1989 to be propagated in a nursery and maintained until the success of the transplantation efforts could be adequately assessed.

Criteria for Success: Success would be based on the number of (trans)plants that grow and reproduce.

Project Success: Unknown. No information available in EPP files.

Date Project Initiated: Fall 1988.

IV.A.23. *Monardella linoides* ssp. *viminea* (Willowy Monardella): State endangered; Federal Candidate C3; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: None. Mitigation was required for the California Department of Transportation (Caltrans) construction in 1983 of an I-15 gap closure and the construction of State Route 52 from I-805 to Santo Road.

Mitigation-Related?: Yes.

Project Objectives: The project objective was simply to offset losses of this plant species caused by construction of the highway projects.

Project Methods: For the State Route 52 project, Caltrans collected a total of 55 individual *M. linoides* ssp. *viminea* plants within the impacted area, and collected green cuttings of this species for reintroduction into suitable habitat within the project area. For the two projects together, Caltrans collected no more than 50% of each year's seed from populations within the impacted area. Prior to broadcasting of seed, Caltrans reviewed existing sites to characterize the ecological parameters of the species.

Criteria for Success: None stated explicitly.

Project Success: Progress reports were submitted in November 1983, April 1984, June 1985, and May 1986. The 1986 report stated that from June 1985 to December 1985, approximately 389 (additional) seedlings died, from the earlier total of 509 plants. This was the result of overcrowding in the nursery.

Two of the original 16 containerized salvaged plants died by June 1985. By December 1985, an additional eight plants had died.

Findings in the 1986 report were: (1) salvaged *M. linoides* ssp. *viminea* plants required parent soil to survive; (2) plants in nursery conditions need to be aggressively pruned; (3) nursery containers must be widely spaced; (4) *M. linoides* ssp. *viminea* is easily propagated from seed and cuttings, and, (5) transplantation would be at a suitable site in Murphy Canyon.

Date Project Initiated: 1983.

IV.A.25. *Oenothera deltoides* ssp. *howellii* (Antioch Dunes Evening Primrose): State endangered; Federally endangered; CNPS List 1B.

Respondent: Ms. Joy Albertson, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex.

Project Name and Description: "Vaca Dixon-Contra Costa 230-kV Reconductoring Project: Habitat Protection and Enhancement for Antioch Dunes." Pacific Gas and Electric Company (PG&E) reconductored the San Joaquin River crossing of the Vaca Dixon-Contra Costa 230 kV transmission line in the fall of 1988. The project took place specifically on the Sardis Unit of the Antioch Dunes National Wildlife Refuge (ADNWR), east of the town of Antioch. USFWS personnel conducted a Section 7 consultation with PG&E before granting access permit. (see IV.A.12 for more details.)

Mitigation Related?: Yes.

Project Objectives: Objectives were: (1) protection of habitat from future damage caused by construction/repair activities; (2) transplantation of listed species from access corridor to allow vehicle access to the tower; (3) establishment of new subpopulations of *Oenothera deltoides* ssp.*howelii* (and *Erysimum capitatum* var. *angustatum*); (4) enhancement of existing populations; and, (5) determination of whether direct seeding or transplantation of nursery liners is preferable.

Project Methods: Plants from the PG&E east parcel access corridor were transplanted either to other locations on the parcel or to the Sardis Pit area. A small circular area was first cleared of all vegetation, then an appropriately sized hole was dug. A plant was placed in the hole and soil was firmly packed around it. Nursery grown plants were planted in a similar manner in pre-selected sites on the PG&E and Sardis Pit Parcels.

Seed germination for *Oenothera deltoides* ssp. *howellii* was poor: only 10 seedlings survived to be planted. More seedlings were to be outplanted in December 1990. Cost of

the nursery-grown seedlings was estimated at $0.30/seedling; 377 seedlings produced; therefore it cost $113.10.

Criteria for Success: The replacement of the plants that were destroyed by the construction, specifically 160 *O. deltoides* ssp. *howellii* seedlings and 230 *E. capitatum* var. *angustatum* seedlings was the criterion.

Project Success: Respondent felt that the project was partially successful.

Date Project Initiated: April 5, 1989, for transplantation; January 1990 for seedling outplanting.

IV.A.26. *Opuntia basilaris* ssp. *treleasei* (Bakersfield Cactus): State endangered; Federal endangered; CNPS List 1B.

1) Respondent: James Brownell, California Energy Commission, Sacramento.

Project Name and Description: "Kern River Cogeneration Power Plant Project." Project involved the construction of a cogeneration power plant along the Kern River in 1983-85.

Mitigation-Related?: Yes.

Project Objectives: Objective of the mitigation project was to keep the cactus located at the edge of the road from being destroyed by truck traffic during construction.

Project Methods: Cactus pads were collected and allowed to callus. Approximately two weeks later, the pads were taken to the transplantation site. The receptor site is within the California Living Museum (CALM) property, a non-profit, privately-run educational program. CALM is located east of Bakersfield within the native range of *Opuntia basilaris* var. *treleasei*.

The receptor site had been weeded to remove non-native annual grasses, and soil had been loosened to allow the callus end of the pads to be placed in the soil. One hundred fifteen (115) cactus pads were positioned in nine (9) clumped in two (2) nearby areas. The receptor site was visited each year for three (3) years, and grasses were cleared at each

visit.

Criteria for Success: Success was achieved if the cactus flourished at the site.

Project Success: The project was considered successful, because the new plants were established wherever pads were planted.

Date Project Initiated: October 1983.

2) Respondent: Rick York, California Energy Commission, Sacramento, and data obtained from EPP files.

Project Name and Description: "Sycamore Cogeneration Project." Project involved the mitigation of operation activities of the Sycamore Cogeneration Company. A population of *Opuntia basilaris* var. *treleasei* became vulnerable to loss from erosion on a slope that was cut prior to construction of the project.

Mitigation-Related?: Yes.

Project Objectives: Sycamore Cogeneration Company, as part of the conditions of certification by the California Energy Commission, agreed to protect *Opuntia basilaris* var. *treleasei* in the main power plant area, pipeline right-of-ways, transmission line right-of-ways, access roads and the fuel oil storage area. If the Bakersfield cactus was disturbed, Sycamore agreed to transplant the affected stands to another area within the project vicinity in a manner similar to that described for the Kern River Cogeneration Project.

Project Methods: No details are provided in the Mitigation Agreement (MA). Information in EPP files indicates that Sycamore Cogeneration Company objected to the five-year monitoring stipulation in the MA.

Criteria for Success: No information was received.

Project Success: No information was received.

Date Project Initiated: 1989.

IV.A.27. *Orcuttia viscida* (Sacramento Orcutt Grass): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Mr. Barry Hecht, Balance Hydrologics, Inc., Berkeley.

Project Name and Description: "Sunrise/Douglas Wetland Protection and Creation Program", Sacramento County. Project involved mitigation for two housing developments along Sunrise Boulevard, Sacramento County. Techniques for mitigation relocation/transplantation are "pending."

Mitigation-Related?: Yes.

Project Objectives: The objective for both projects was to re-establish species in vernal pools and freshwater seasonal wetlands within a 350-acre wetland preserve.

Project Methods: Methods are "pending."

Criteria for Success: Respondent reports two specific criteria: 1) Survival for 5 years in 90% of the pools and wetlands to which individuals of *Orcuttia viscida* are transplanted; and, 2) noticeable vigor and expansion of the range of *Orcuttia viscida* in 50% of the pools/wetlands into which individuals are transplanted.

Project Success: Decision of success is "pending."

Date Project Initiated: Project is "on-going;" presumably construction has not yet begun.

IV.A.28. *Pentachaeta lyonii* (Lyon's Pentachaeta): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Mr. Carl B. Wishner, Envicom Corporation, Calabasas.

Project Name and Description: "Lake Sherwood Golf Course." The mitigation that was prepared by Envicom Corporation involved a salvage and restoration plan for *Pentachaeta lyonii* at the Lake Sherwood Golf Course site in Ventura County. The planning unit (Planning Unit No. 1) consisted of a 163-acre golf course, driving range, clubhouse, 146 single-family lots, and 4 estate lots, ranging from 0.3 to 12.7 acres.

Mitigation-Related?: Yes.

Project Objectives: Project objectives included: (1) maintenance of at least one site occurrence of *Pentachaeta lyonii* in perpetuity; (2) maintenance of at least one occurrence in an undisturbed state until the majority has flowered and seeded; (3) harvest of mature seed to establish a "germ plasm" collection at the Rancho Santa Ana Botanic Garden (RSABG), and to establish a living collection; (4) removal of top soil at impacted site for seed collection; (5) development of a five-year monitoring program; and, (6) conduction of a phytosociological study to determine habitat parameters.

Project Methods: Seed of *Pentachaeta lyonii* was collected by hand and by using a portable hand vacuum, yielding 7.75 grams. It was held cryogenically by the RSABG. Just before site grading, a target soil removal from areas of high plant density (70 flats of soil) was conducted, followed by overall surface scraping and stockpiling of about 2 yd^3 of soil.

Salvaged soil was redistributed of 0.1 acre *ex situ* just prior to the first major fall storm (November 1988). A small amount of seed and three (3) flats of salvaged soil were distributed onto the preserved *P. lyonii* location.

Prior to the extirpation of the *Pentachaeta lyonii* site, a grid system of 1 m squares was established using string and nails. Presence and ranked order estimates of density for each square meter were recorded. The identity of all species present within the areal extent of *P. lyonii* was recorded. A random sample of 60 quadrats was investigated for species presence. These data were subjected to an ordination analysis, along with similar data from other sites of occurrence. The *ex situ* site was similarly gridded in the spring of 1989. All species were recorded, and each quadrat checked for *Pentachaeta lyonii*.

Criteria for Success: Respondent indicated that the plan did not specifically designate criteria for success.

Project Success: Success in the stated context was not achieved. The respondent suggested that the plan for salvage was inadequate.

Date Project Initiated: May 1988.

IV.A.29. *Pogogyne abramsii* (San Diego Mesa Mint): State endangered; Federally endangered; CNPS List 1B.

Respondent: Drs. C.H. Black and Paul Zedler, Dept. Biology, San Diego State University.

Project Name and Description: "Caltrans Del Mar Mesa Vernal Pools" and "U.S. Navy North Miramar Project Mitigation." As background, California Department of Transportation (Caltrans) had two major projects on Kearny Mesa that eliminated vernal pools. The first project was mitigated by the purchase of 26 acres of prime vernal pool habitat on Del Mar Mesa and a second acquisition of an additional 52 acres at Del Mar Mesa. This second acquisition was to be used in an experiment to create artificial pools capable of supporting *Pogogyne abramsii* and *Eryngium aristulatum* var. *parishii* (Zedler and Black 1988). Respondents did not explain the Mirimar Project. (see IV.A.11 for additional information).

Mitigation-Related?: Yes.

Project Objectives: For both projects, the objective was to create vernal pool habitat for *Eryngium aristulatum* var. *parishii* and *Pogogyne abramsii*.

Project Methods: A set of 40 artificial basins was excavated in December 1986, and 387 were inoculated with material collected from the natural pools on Del Mar Mesa.

Criteria for Success: Respondents did not specifically designate criteria for success.

Project Success: Respondents feel that the projects are "not yet" successful because the rare species have not attained population densities found in the natural pools.

Date Project Initiated: December 1986.

IV.A.30. *Pseudobahia peirsonii* (Tulare Pseudobahia): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: John Stebbins, California State University, Fresno.

Project Name and Description: "Round Mountain Flood Control Project," initiated by the Fresno County Metro Flood District. Project plans are being drafted at this time.

Mitigation-Related?: Yes.

Project Objectives: Project plans are being drafted at this time. Net yet available.

Project Methods: Project plans are being drafted at this time. Net yet available.

Criteria for Success: Project plans are being drafted at this time. Net yet available.

Project Success: Net yet available.

Date Project Initiated: Presumably the project has not yet begun.

IV.A.31. *Sedum albomarginatum* (Feather River Stonecrop): Not State listed; Federal Candidate C1; CNPS List 1B.

Respondent: Sharon Villa, California Department of Transportation (Caltrans), Redding.

Project Name and Description: "Feather River Canyon Storm Damage Repair." The project involved the repair of the February 1986 storm damage to State Route 70 in Plumas County. Work included widening at three (3) spot locations where the highway was reduced to a single lane. Initially, the existing rock slopes were cut back approximately 15 feet to restore two traffic lanes. The roadway was later realigned away from the East Branch North Fork Feather River.

Mitigation-Related?: Yes (for a federal candidate).

Project Objectives: The overall goal of the mitigation project was to reduce the severity of project impacts on *Sedum albomarginatum*. Specific project objectives were : (1) avoid unnecessary or inadvertent damage to the population by restricting habitat disturbance to those areas that are located within the slope lines; (2) salvage individual *S. albomarginatum*

plants from project impact areas prior to construction, and reintroduce these plants on suitable slopes within the immediate area following construction; (3) collect information on the distribution, density, and microhabitat preferences of *S. albomarginatum* within the project area to guide reintroduction efforts; and, (4) monitor the survival of re-established plants for a period of five years to evaluate the effectiveness of transplantation as a mitigation measure of *Sedum albomarginatum.*

Project Methods: An unspecified number of plants (up to 500 individuals) were salvaged from the impacted site, placed in a burlap bag and transferred to labeled flats. These were maintained in a lath house at the Butte College horticultural facility. The salvaged plants were returned to the area of origin and transplanted after the new highway slopes had been constructed. Two plantings were performed, one in Fall 1986 and the other in Spring 1987. Each plant was permanently marked with a numbered aluminum tag wired to a steel spike driven into the ground.

Criteria for Success: None were developed.

Project Success: One hundred fifty eight (158) plants were outplanted in Fall 1986 and an additional 158 were outplanted the following spring. Only 14 (8.8% survival rate) survived the fall transplant, and only three (3) individuals (1.9% survival rate) survived the spring transplant.

Date Project Initiated: June 1986.

IV.A.32. *Sidalcea pedata* (Bird-Footed Checkerbloom): State endangered; Federally endangered; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: "*Sidalcea pedata* Transplantation Project." The project involved the construction of a store (Big Bear K-Mart) in the city of Big Bear Lake (San Bernadino County). The mitigation involved the transplantation of eleven (11) whole

plants.

Mitigation-Related?: Yes.

Project Methods: Terms of the Mitigation Agreement (MA) between CDFG and K-Mart Corporation stipulated that all four *Sidalcea pedata* plants on the impacted site were to be translocated to a protected site approximately 0.25 miles away, owned by The Nature Conservancy. However, by the time the MA was signed, several individuals of *S. pedata* were destroyed by equipment operations from an industrial contractor's yard adjacent to the K-Mart proposed site. The remaining twelve plants (10 mature and two seedlings) were transplanted by means of a Vermeer hydraulic spade during November 1988.

Site preparation included the removal of several tons of asphalt debris and light discing to reduce the compaction of the recipient area. The 0.9 acre parcel was fenced with a split rail around its entire perimeter.

Criteria for Success: None stated in the materials available for review.

Project Success: As of 16 May 1990, 10 of the 12 transplants survived to reproduce and one seedling transplant survived, despite two years of drought. This represents a 90% survival rate for the mature plants. T. Krantz, the contractor from Nativescapes responsible for the transplantation effort, suggests that the project was at least initially successful.

Date Project Initiated: November 1988.

IV.B. Endangered, Threatened, and Rare Plant Species Involved in Research-Related ,Transplantation, Relocation and Reintroduction Projects

IV.B.1. ***Amsinckia grandiflora*** (Large-Flowered Fiddleneck): State endangered; Federally endangered, CNPS List 1B.

Respondent: Mr. Kevin Shea, East Bay Regional Parks District (EBRPD), Oakland, and

data obtained from EPP files.

Project Name and Description: "*Amsinckia Grandiflora* Experimental Reintroduction." EPP contracted with Dr. Bruce Pavlik of Mills College, Oakland, to re-establish *Amsinckia grandiflora* at Black Diamond Mines Regional Reserve, a park within the East Bay Regional Park District (Pavlik 1990). The project included: (1) reintroduction of *Amsinckia grandiflora* to its historic location near Antioch, California ("Stewartville"), (2) monitoring the new population; and, (3) experimentally testing the effects of burning, clipping, and herbicide on survivorship and seed production of *Amsinckia grandiflora.* These results would be used to establish additional satellite populations of *Amsinckia grandiflora.*

Mitigation-Related?: No.

Project Objectives: Establishment of at least four new *Amsinckia* populations within its historic range in order to reduce the probability of extinction.

Project Methods: A 14 x 17 m plot was fenced with barbed wire to exclude livestock. Within the area, 20, 2 x 2 m plots of 4 treatments were selected by a stratified random design. Five plots served as controls, five plots were burned after sowing, five plots were hand-clipped, and five plots were sprayed with a dilute solution of a grass-specific herbicide (fluazifop-p-butyl, known as "Fusilade®", produced by the ICI Corporation).

Amsinckia grandiflora nutlets (3460 total), 1800 from a naturally occurring population (Site 300 source) and 1660 grown at the University of California at Davis were sown on October 19 and 20. Each plot was planted with 160 nutlets by pressing each into a shallow depression in the mineral soil. The nutlets were covered with approximately 20 cc of loose native soil to a depth of 1 cm. No supplements of water or nutrients were applied during the experiment.

Amsinckia grandiflora plots were monitored for the following parameters: (1) germination, (2) stress factors, (3) mortality, (4) phenology, (5) reproductive survivorship,

(6) pin-thrum ratio, and (7) nutlet output per plant and per plot.

Criteria for Success: Not explicitly stated, but the success of the reintroduction effort was based on the result that the maximum nutlet output in the experimental plots exceeded the predicted nutlet output (based on laboratory studies).

Project Success: Pavlik reported the project a success in its first year, based upon the production of approximately 35,000 seeds from 1140 individuals, representing a ten-fold increase over the number (3460) of individuals used in the experiment.

Date Project Initiated: October, 1989

IV.B.2. ***Antennaria flagellaris*** (Stoloniferous Pussytoes): Not state or federally listed, but meets CEQA criteria (§15380?) at the time of transplantation; CNPS List 4.

Respondent: Mr. Gary Schoolcraft, U.S. Bureau of Land Management, Susanville.

Project Name and Description: None. U.S. BLM initiated a transplantation project, moving a portion of a population consisting of approximately 10,000+ individuals, that at the time (1983), was considered the only known population in California. Transplantation was attempted as an experiment because it was believed that gold mining would return to the area, and the population was located at the edge of the previous mining activity.

Mitigation-Related?: No.

Project Objectives: Project was initiated to determine whether transplantation of *Antennaria flagellaris* could be used in the future as mitigation.

Project Methods: Plants were removed in groups from a large (>10,000+ individuals) by shovel. These were then transplanted immediately in flats to the relocation sites. Groups and soils were kept in tact, as much as possible. Some plants were watered with a vitamin B1 mixture, while others were not supplemented. No difference was observed in growth between these two groups.

Each summer following the transplantation, the total number of plants (both live

and dead) were counted. No transplanting report was prepared, but internal memoranda describing the transplantation and the concluding activities were prepared. Estimated cost of the transplantation was 1 work day per transplant.

Criteria for Success: Establishment and reproduction of the plants on site, to sufficient numbers to guarantee existence of the population.

Project Success: Not successful. Of the >400 plants transplanted into 4 different populations, only one newly established population exists. This consists of only 17 plants after 6 years. All other died. Schoolcraft suggested that because the plant is a short-lived perennial that reproduces vegetatively primarily by stolons, the receptor site may have had an inappropriate soil texture to allow adequate vegetative reproduction.

Date Project Initiated: October 1983.

IV.B.3. *Arabis macdonaldiana* (MacDonald's Rock Cress): State endangered; Federally endangered; CNPS List 1B.

Respondent: Pardee Bardwell, U.S. Bureau of Land Management (U.S. BLM) and Michael Baad, California State University, Sacramento.

Project Name and Description: "Geographic Distribution of Rare Plants on Public Lands Within the Red Mountain Study Area and A Study of the Population Dynamics and Reproductive Biology of McDonald's Rock-Cress [sic] (*Arabis macdonaldiana*)." The project was contracted by Dr. Baad with the U.S. BLM to determine the: (1) geographic distribution of rare plants on Red Mountain public lands; and, (2) population dynamics and reproductive biology of MacDonald's rockcress (Baad 1987).

Mitigation-Related?: No.

Project Objectives: The overall project objective of the contract was to determine why *Arabis macdonaldiana* is not more widely distributed within the rocky habitats of Red Mountain. The project was initiated in part in response to the 1984 Recovery Plan for

MacDonald's rock cress.

Project Methods: As part of this contract, in November 1985, Dr. Baad planted 30 1 m^2 plots with 100 *Arabis macdonaldiana* seeds each, over a wide range of habitats on Red Mountain. Several plots also received seedlings germinated from seed under greenhouse conditions. These were monitored during 1986.

Criteria for Success: None.

Project Success: The report notes that there was extremely poor germination success by *Arabis macdonaldiana* over the wide range of habitats into which they were outplanted. Dr. Baad concluded that this species has a relatively low rate of germination even in its preferred habitat. Also, the transplants did not do well, surviving in only 3 of the original plots. All but 5 of the original 25 transplants that remained were completely grazed and/or torn out of the ground by herbivores.

Date Project Initiated: Spring 1984.

IV.B.4. ***Arctostaphylos hookeri* var. *ravenii*** (Raven's Manzanita): State endangered; Federally endangered; CNPS List 1B.

Respondent: Ms. Terri Thomas, U.S. National Park Service, Golden Gate National Recreation Area, San Francisco.

Project Name and Description: "Raven's Manzanita Recovery Plan." The "relocation" project was initiated as part of the Raven's manzanita recovery plan.

Mitigation-Related?: No.

Project Objectives: To expand the number of individuals in the population, so that the single remaining individual could remain undisturbed.

Project Methods: Approximately 60 cuttings were taken and propagated by the Saratoga Horticultural Foundation and the University of California Botanic Garden. Later, 60 plants were outplanted in the Presidio in sites identified as similar to the original serpentine site of

the parent plant. Plants were watered periodically throughout the first season. An unreported number of seeds were collected, soaked in concentrated sulfuric acid for three hours, and then washed. They were then stratified in moist peat for three months at room temperature and then for three months in the refrigerator.

Criteria for Success: The criterion for success for the cuttings was simply survival. For the seeds, the criterion for success has not yet been determined, because they are still experimenting with collection times, germination techniques, *etc.* However, no mechanism for protection of the transplants has been initiated.

Project Success: Of the approximately 160 cuttings taken and grown at various local botanical gardens, 60 plants were eventually outplanted. It is not clear from the respondent whether any of these remaining 60 have died, but it appears that they have not.

Date Project Initiated: January 1987.

IV.B.5. ***Bensoniella oregana*** (Bensoniella): State rare; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. Dave Imper, North Coast Chapter, California Native Plant Society, Eureka.

Project Name and Description: "*Bensoniella* Transplant Project." Project was initiated in 1979 by the Six Rivers National Forest because downcutting of stream channels appeared to threaten populations of *Bensoniella oregana.* Approximately 50 rosettes were removed from the Smokehouse Creek parcel and transplanted to Groves Prairie, east of Willow Creek, in similar habitat.

Mitigation-Related?: No.

Project Objectives: No specific objectives, although generally the Forest Service wanted to prevent the demise of the streamside populations of *Bensoniella oregana.*

Project Methods: Whole plants (rosettes) were removed from the Smokehouse Creek

Parcel (an outholding held by Six Rivers National Forest specifically for *Bensoniella oregana*), and transplanted to Groves Prairie, east of Willow Creek in a similar habitat of white fir (*Abies concolor*)/incense cedar (*Calocedrus decurrens*). Transplants were monitored from 1980-1985.

Criteria for Success: Not clearly defined, other than short-term survival. Respondent noted that a "rather inadequate" measure of vigor was included in the original monitoring plan.

Project Success: Success was not clearly defined, but some rosettes survived. During the first year, a large increase (>100%) in the number of rosettes and inflorescences was observed. However, there has been an apparent failure for these transplants to reproduce sexually. Respondent indicated that so little of the biology of this species is known that it is not clear whether *Bensoniella oregana* reproduces sexually anywhere or whether sexually reproduction is intermittent. Also, respondent indicates that the transplant population has declined significantly within the last year.

Date Project Initiated: 1978-79.

IV.B.6. *Cordylanthus palmatus* (Ferris' Bird's Beak): State endangered; Federal endangered; CNPS List 1B.

Respondent: Dr Larry Heckert, Jepson Herbarium, University of California, Berkeley.

Project Name and Description: None stated.

Mitigation-Related?: No.

Project Objectives: None stated. Presumably the objective of Dr. Heckert was to establish a self-sustaining population of *Cordylanthus palmatus* at the Mendota Wildlife Refuge.

Project Methods: An unspecified number of individuals was collected from somewhere outside the wildlife refuge and transplanted to the refuge. The population lasted for over 10 years, but eventually died out. At some time during this project, a naturally-occurring

population was discovered within the Mendota Wildlife Refuge.

Criteria for Success: None stated.

Project Success: Project was successful about a decade, but not for the long term.

Date Project Initiated: late 1970's.

IV.B.7. *Dudleya cymosa* ssp. *marcescens* (Santa Monica Mountains Dudleya): State rare; Federal Candidate C2; CNPS List 1B.

Respondent: Ms. D.A. Hoover, Woodland Hills, California.

Project Name and Description: "Soltice Canyon Native Plant Project." Volunteers from the California Native Plant Society (CNPS) proposed to eradicate invasive exotic species and replace them at Soltice Canyon Park with species native to the Santa Monica Mountains. This project included the reintroduction of *Hemizonia minthornii* and *Dudleya cymosa* ssp. *marcescens*. (see IV.B.8 for more details).

Mitigation-Related?: No.

Project Objectives: Objectives as stated were to expand the protected sites for the relatively rare native species and to learn practical methods for safe propagation without threatening native populations.

Project Methods: Individuals of *D. cymosa* var. *marcescens* were collected (salvaged) from along a road in Red Rock Canyon that was to be graded for fire-break maintenance. Approximately 7-8 individuals were lifted from the hard-packed roadside soil and transplanted to soil-filled pockets on a rocky berm on Humbolt Terrace at Soltice Canyon Park. Each plant was watered by hand for several months. The respondent suggested that the rocky setting protects the plants from gophers and also provides excellent drainage.

Plants were monitored by CNPS members through periodic inspections. Visits included weeding of competing exotics (*e.g.*, castor bean, tree tobacco, mustard, various thistles, *etc.*) and handwatering of additional native species. Total cost of the project was

$130.00 (gas @ $10.00 and paid assistance at $120.00).

Criteria for Success: None stated for *Dudleya cymosa* var. *marcescens*.

Project Success: For *Dudleya cymosa* var. *marcescens*, the respondent felt that the transplantation was successful because the transplanted plants established successfully. However, the respondent also noted that many more individuals of *D. cymosa* var. *marcescens* were lost due to road-scraping. The CNPS hopes to expand this reintroduced population through future off-site seed collection, germination, and transplantation.

Date Project Initiated: 1987; project on-going.

IV.B.8. ***Hemizonia minthornii*** (Santa Susana Tarplant): State rare; Federal Candidate C2; CNPS List 1B.

Respondent: Ms. D.A. Hoover, Woodland Hills, California.

Project Name and Description: "Soltice Canyon Native Plant Project." Volunteers from the California Native Plant Society (CNPS) proposed to eradicate invasive exotic species and replace them at Soltice Canyon Park with species native to the Santa Monica Mountains. This project included the reintroduction of *Hemizonia minthornii* and *Dudleya cymosa* ssp. *marcescens*. (see IV.B.7 for more details).

Mitigation-Related?: No.

Project Objectives: Objectives as stated were to expand the protected sites for the relatively rare native species and to learn practical methods for safe propagation without threatening native populations.

Project Methods: Seed was collected from two off-site populations in the Santa Monica Mountains (Calabasas Peak and Castro Peak), and stored for several weeks. These failed to germinate, but a second collection was made, and seeds were sown the same day of collection. These seeds germinated and subsequently were transplanted to a screen-covered seed bed in Soltice Canyon Park. The populations were subject to gopher predation and

overwatering, however.

Plants were monitored by CNPS members through periodic inspections. Visits included weeding of competing exotics (*e.g.*, castor bean, tree tobacco, mustard, various thistles, *etc.*) and handwatering of additional native species. Total cost of the project was $130.00 (gas @ $10.00 and paid assistance at $120.00).

Criteria for Success: None stated for *Hemizonia minthornii.*

Project Success: Respondent reported that virtually 100% of the seeds germinated, but the very young transplants died from drought. Approximately 10 individuals survived to flower. The Castro Peak seedlings will be transplanted to various locations in the park to test their ability to survive in each (different?) site.

Date Project Initiated: 1987; project on-going.

IV.B.9. *Oenothera wolfii* (Wolf's Evening Primrose): Not California State listed; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. Dave Imper, North Coast Chapter, California Native Plant Society, Eureka.

Project Name and Description: None. Project involved the population expansion within the type locality of *Oenothera wolfii* at Luffenholtz Beach. In December, 1988, 3 individuals of *Oenothera wolfii* were transplanted from Luffenholtz parking area to adjacent habitat, along with two greenhouse seedlings and considerable amounts of seed.

Mitigation-Related?: No.

Project Objectives: The stated objective was to reduce the impacts of repaving, trampling, and vehicular use to populations of *Oenothera wolfii* at Luffenholtz Beach.

Project Methods: Seeds were collected and grown in respondent's greenhouse. Approximately 80 seedling rosettes ranging from 1 - 4 inches in diameter were outplanted on December 26, 1989, in four small areas east of Scenic Drive, south of the residence

driveway. In addition, a small amount of seed was planted directly.

Criteria for Success: None stated.

Project Success: Late summer mortality was high. Only 55 seedlings from 7000+ seeds currently survive. Five of the 7 onsite transplants survived, and one of the two greenhouse seedlings. However, the respondent suggests that both seeding and transplantation are potentially viable methods for mitigating impacts on this species, and for expanding small populations.

IV.C. Project Proponents

Of the 46 projects reviewed in this analysis, 17 (37%) were conducted by private businesses involved in housing construction, outdoor recreational facilities, and business offices (Table 4). However, state services such as the California Department of Transportation, California Department of Water Resources, California Department of Parks and Recreation, and the services of two counties (Sonoma and Fresno) together were involved in a total of 15 projects (33%). Finally, an additional 5 projects (11%) were conducted by energy companies (both private and public utilities) (Table 4). The remaining projects were research-related or mitigation-related projects conducted by various agencies of the federal government for a variety of reasons,

V. DISCUSSION OF FINDINGS

V.A. Mitigation Successes

Seven transplantation attempts were considered successful in this analysis. These attempts involved the plant species *Amsinckia grandiflora, Dudleya cymosa* ssp. *marcescens, Holocarpha macradenia, Lasthenia burkei, Opuntia basilaris* var. *treleasei*, and *Sidalcea pedata.* Of these species, the first two were not involved in mitigation-related transplantation efforts. However, the *Amsinckia* project appears to have been so successful because of the great detail and care taken in

TABLE 4. PLANT SPECIES INVOLVED IN TRANSPLANTATION, RELOCATION, OR REINTRODUCTION PROJECTS, PROJECT PROPONENTS, AND DEGREE OF MITIGATION SUCCESS.

SPECIES	PROJECT PROPONENT	PROJECT NAME	PROJECT SUCCESS
Acanthomintha ilicifolia	1) Pardee Company	Westview Planned Residential Development	On-going
	2) Shea Homes	Palos Vista Development	On-going
	3) Pardee Company	Reparation for Sabre Springs Development	On-going
	4) Unknown	Indian Hill, Las Brisas, & Spyglass	Limited success
Amsinckia grandiflora	N/A: Research-Related	*Amsinckia grandiflora* Experimental Reintroduction	Successful
Antennaria flagellaris	U.S. BLM	None	Not successful
Arabis macdonaldiana	N/A: Research-Related	Geographic Distribution of Rare Plants on Public Lands Within the Red Mountain Study Area....	Not successful
Arctostaphylos hookeri var. *ravenii*	N/A: Research-Related	Raven's Manzanita Recovery Plan	On-going
Bensoniella oregana	N/A: Research-Related	*Bensoniella* Transplant Project	Limited success
Blennosperma bakeri	1) Christopherson Homes	Montclair Park	Limited success
	2) Cobblestone Development Corporation	San Miguel Estates	On-going
Brodiaea filifolia	Baldwin Company	College Area Specific Plan in San Marcos	On-going
Brodiaea insignis	Dept. Water Resources	Kaweah Reservoir Dam Expansion	Planning stage
Calochortus greenei	Siskiyou County	None	Not successful
Chorizanthe howellii	UC Davis	None	On-going
Cirsium occidentale var. *compactum*	Calif. Dept. Transportation	Little Pico Bridge Replacement & Piedras Blancas Shoulder widening	Partial success
Cordylanthus palmatus	N/A: Research-Related	None	Partial success
Croton wigginsii	U.S. BLM	None	Not successful
Dudley cymosa ssp. *marcescens*	N/A: Research-Related	None	Successful
Eriastrum densifolium ssp. *sanctorum*	Calif. Dept. Transportation	Santa Ana Woollystar Relocation Project	Not successful
Eriophyllum mohavense	Calif. Energy Commission	LUZ SEGS VII	Not successful
Eryngium aristulatum var. *parishii*	Calif. Dept. Transportation	Caltrans Del Mar Mesa Vernal Pools	Partial success
Erysimum capitatum var. *angustatum*	Pacific Gas & Electric Co.	Vaca Dixon-Contra Costa 230-kV Reconductoring Project....	Partial success
Erysimum menziesii	1) UC Davis	None	On-going
	2) Unknown	Spanish Bay	No information
	3) Unnamed timber company	None	On-going
Erysimum teretifolium	Lone Star Industries, Inc.	Revegetation of Olympia Quarry	Planning stage
Gilia tenuiflora ssp. *arenaria*	Unknown	Spanish Bay	No information
Hemizonia increscens ssp. villosa	Texaco	Gaviota Interim Marine Terminal	On-going
Hemizonia minthornii	1) N/A: Research-Related	None	Not successful
	2) Las Virgenes Municipal Water District	Santa Susana Tarplant Mitigation Program Twin Lakes Tank No. 2	Not successful
	3) Chateau Builders	Woolsey Canyon Development	Planning stage
Holocarpha macradenia	Nylen Company	Hilltop Commons Development	Successful
Lasthenia burkei	1) Unknown	Airport Blvd. Business Park	Successful
	2) Sonoma Co. Airport	Sonoma Co. Airport Expansion	Successful
	3) Cobblestone Development Corporation	San Miguel Estates	On-going
	4) Sonoma County	County of Sonoma Public Service Area 31 Waste Water Storage Pond	On-going
Lilaeopsis masonii	1) Dept. Water Resources	Baker Slough Bank Revetment	On-going
	2) Dept. Parks & Recreation	None	Planning stage
Lupinus tidestromii var. *tidestromii*	Unknown	Spanish Bay	No information
Lupinus milo-bakeri	Calif. Dept. Transportation	None	Unknown

TABLE 4. PLANT SPECIES INVOLVED IN TRANSPLANTATION, RELOCATION, OR REINTRODUCTION PROJECTS, PROJECT PROPONENTS, AND DEGREE OF MITIGATION SUCCESS (cont.).

SPECIES	PROJECT PROPONENT	PROJECT NAME	PROJECT SUCCESS
Mahonia nevinii	RANPAC Corporation	Vesting Tentative Tract No. 23267	Unknown
Monardella linoides ssp. *viminea*	Calif. Dept. Transportation	None	Not successful
Oenothera deltoides ssp. *howellii*	Pacific Gas & Electric Co.	Vaca Dixon-Contra Costa 230-kV Reconductoring Project....	Partial success
Oenothera wolfii	N/A: Research-Related	None	Not successful
Opuntia basilaris var. *treleasei*	1) Calif. Energy Commission	Kern River Cogeneration Power Plant Project	Successful
	2) Sycamore Cogeneration Company	Sycamore Cogeneration Project	Unknown
Orcuttia viscida	Unknown	Sunrise/Douglas Wetland & Creation Program	Ongoing
Pentachaeta lyonii	Unknown	Lake Sherwood Golf Course	Not successful
Pogogyne abramsii	Calif. Dept. Transportation	Caltrans Del Mar Mesa Vernal Pools	Partial success
Pseudobahia peirsonii	Fresno Co. Metro Flood Control District	Round Mountain Flood Control Project	Planning stage
Sedum albomarginatum	Calif. Dept. Transportation	Feather River Canyon Storm Damage Repair	Not successful
Sidalcea pedata	K-Mart Corporation	*Sidalcea pedata* Transplantation Project	Successful

all phases of the research, and that is was peformed by a conscientious and skilled researcher, Dr. Bruce Pavlik. In this instance, the biology of the species was investigated in full, and various relevant (receptor) site treatments were included as an experimental component of the research. It appears crucial that the soil and habitat requirements of the species be understood completely before successful establishment can be assured.

As for the success of the nonmitigation-related transplantation of *Dudleya cymosa* ssp. *marcescens* and the mitigation-related *Opuntia basilaris* var. *treleasei*, these species are succulents which in general, have relatively easy horticultural requirements. Succulents by their biology are rather hardy and tolerant of drought and other forms of disturbance. Therefore, in the case of the Bakersfield cactus, using industry standards for cutting and callus formation may have insured its successful transplantation for the Kern River Cogeneration Power Plant Project. However, the receptor site was also carefully prepared to receive the cactus pads, and this again, appears to be important in assuring success of the transplantation.

The reasons for the success of the thwo *Lasthenia burkei* vernal pool projects (Sonoma County Airport Business Park, and the Sonoma County Airport Expansion are not clear. The issue of vernal pool creation, mitigation, and enhancement is exceptionally contentious among practicing biologists in the State, and there are many differing opinions about vernal pool mitigation "success" (see Ferren and Gevirtz 1990, for example). In a survey such as this, we must accept the accessment of success by the parties responsible for the mitigation, if the established criteria are met and it meets the criteria imposed by this review. In all three cases with *Lasthenia burkei*, populations were established with a greater number of individuals than there present originally (*i.e.*, no individuals). However, because these projects have been on-going for less than 10 years, the long-term viability of the populations is not yet known.

What is also interesting about the vernal pool projects in Sonoma County is that they also involved *Blennosperma bakeri*. Although these projects are technically on-going and were not evaluated as either successful or unsuccessful in this analysis, the early reported results indicate that this species will also successfully establish at created vernal pools. However, one respondent (N. Harrison, San Rosa Jr. College) suggested that despite the purported success of vernal pool creation in Sonoma County, this is an "unsuitable" method for mitigation. Preservation is the only viable mitigation method for vernal pool [plants]. She also reported that Sonoma State University [personnel] has tried for 12 years to vegetate an artificial vernal pool by seeding and transplantation from local sources, but without success. It is not clear from this review why there is such a clear discrepancy in the evaluation of mitigation success for Sonoma County's vernal pool plant species. It is likely that philosophic and ethic differences, rather than biology, drive this debate.

The successful mitigation efforts of the last two species, *Holocarpha macradenia* and *Sidalcea pedata*. are not known. For the Santa Cruz tarplant, the salvage of individual plants was accomplished with care, but preparation of the receptor site was not performed. It is possible that *H. macradenia* is a rather weedy species capable of taking advantage of small site disturbances to establish successfully. As for the bird-footed checkerbloom, the individuals were carefully removed from the construction site, the receptor site was prepared to receive the transplanted individuals, and the receptor site fenced for protection from disturbance. The assessment of success may be premature for this species because the project is only in the second year of monitoring, but the first year survival rate is significant (90%).

V.B. Mitigation Failures

Over one quarter (12 out of the 26 projects; 26%) of the transplantation, relocation, and reintroduction projects in this survey are considered failures. They will not be reviewed individually; however, several are notable, and will serve to illustrate the various reasons for a

project's lack of success. The Las Virgenes Municipal Water District's project involving the construction of a water and the consequent destruction of a population of *Hemizonia minthornii* is a controversial mitigation failure that received media attention (Los Angeles Times 1989). Several obvious reasons why this project failed are: (1) seed was collected from plants before it was fully mature (seasoned) and thus subsequent seed germination was poor; (2) plants were collected during the middle of the growing season when they may have been most vulnerable to disturbance; and, (3) because of the nature of the (rock) substrate, individuals were difficult to collect for transplantation. Although an attempt was made to extract individuals carefully, in many cases it appears that the roots had to be broken as individuals were torn from their rock substrate; consequently, few individuals survived.

The difficulties the California Department of Transportation had with the transplantation of *Monardella linoides* ssp. *viminea* again illustrates the problems of native substrate and soils. One of the findings made in the 1986 monitoring report was that this species required its parent material to survive in cultivation. This was discovered after a significant number of individuals had died. For *Antennaria flagellaris*, the respondent suggested that the reason this species did not thrive in its transplantation site was because the soils had an inappropriate soil texture to allow for stoloniferous growth. *Arabis macdonaldiana* is a serpentine endemic, and many such species are difficult to grow in cultivation. Dr. Baad's work demonstrated that this species has poor germination rates even on its native substrate, and did not fare well in any experimental manipulations in the field. Finally, despite serious efforts to control for the unusual edaphic factors that control the distribution of *Eriophyllum mohavense* (and *Chorizanthe spinosa*), transplantation of seeds of the Barstow woolly sunflower and its soil by the California Energy Commission did not succeed. Again, the respondent suggests that the current drought is responsible for the transplantation failure.

Another feature of the mitigation-related transplantation failures is illustrated, again by the California Department of Transportation, in its efforts to transplant *Sedum albomarginatum*. This species is a succulent, and unlike the other succulents in this survey, did not survive its transplantation. It is believed that the transplanted individuals did not survive in large part due to the present drought (Martz, personal communication).

The efforts of the U.S. Bureau of Land Management (BLM) illustrate the problems associated with the transplantation at different life stages. In this instance attempted to transplant seedlings of *Croton wigginsii*. The seedlings were reported as being transplanted with considerable care into an appropriate habitat, but all seedlings died. Because seedlings are a well known to be vulnerable life history stage, manipulations involving seedlings are not likely to succeed.

For other species, such as *Pentachaeta lyonii*, the reasons for failure are not clear. Despite considerable efforts on the part of the consultants to insure mitigation success, including cooperation with the Rancho Santa Ana Botanic Garden for horticultural expertise and sound field methods, the respondent reported that success of the project objectives was not achieved. The reason offered was that the salvage plan was "inadequate."

In summary of the successes and failures of transplantation, relocation and reintroduction of sensitive plant species in California, three broad recommendations can be made that are based on several aspects of the biology of imperiled plant species. These recommendations are:

(1) Individuals should be removed with as little disturbance as possible to the individual, and at a phenologically appropriate time of year when the individual is dormant or photosynthetically inactive;

(2) The receptor site should be of the same habitat quality, particularly with respect to soil

type and its physical characteristics. Various other aspects of the receptor site might include weeding to decrease competition from native and exotic species, watering during times of drought, and fencing and/or other forms of site protection; and

(3) Knowledge of the biology of the organism appears to aid greatly in the design of appropriate horticultural techniques for the preparation of cuttings, transplantation, seed germination, *etc.* This is problematic, however, because the biology of most State-listed species is poorly known. Although some species such as cacti and succulents may be amenable to standard horticultural techniques for propagation, most are not. Therefore, without sufficient knowledge of the biology of impacted species, success of the transplantation, relocation, or reintroduction will not be assured.

V.C. Overview and Summary

Mitigation of impacts to endangered, threatened, and rare plant species is an issue of considerable debate. On the one hand, the Canadian Botanical Association (Fahselt 1988), the American Society of Plant Taxonomists (ASPT 1989), and the Rare Plant Scientific Committee of the California Native Plant Society (CNPS 1990) do not favor mitigation and in point of fact, oppose transplantation as a means of plant preservation except in those instances for which there are no other means of protection. An otherwise doomed population of *Penstemon barrettiae* was transplanted under just such circumstances (Guerrant 1990). Mitigation guidelines propagated by the CNPS (1990) recommend impact avoidance as outlined in the California Environmental Quality Act (CEQA §15370) as the favored mitigation technique.

On the other hand, however, transplantation, relocation, and reintroduction of endangered, threatened, or rare species are routinely performed as mitigation for "unavoidable" project impacts, according to both state and federal environmental legislation. This is currently accomplished in

California for listed plant species through Mitigation Agreements. However, it is remarkable that such potentially harmful activities to State- and (federally-) listed species has, until very recently, been so poorly monitored by all parties (but see new guidelines by Howald and Wickenheiser 1990).

What is equally remarkable is the lack of performance criteria (*i.e.*, criteria for success) of the completed mitigation-related projects reviewed here. Only 15 of the 46 projects (33%) have explicitly defined criteria for success, and until quite recently, there was no consistency in these criteria. Without such "industry" standards, success of translocation, relocation, and reintroduction projects cannot be made objectively. When criteria are explicitly defined, for example the College Area Specific Plan in San Marcos for *Brodiaea filifolia*, mitigation successes can be assessed appropriately.

Such policy statements about transplantation, relocation, or reintroduction as mitigation as those promulgated by the Canadian Botanical Society and the American Society of Plant Taxonomists, combine an ethical viewpoint with a scientific evaluation of plant (and animal) transplantation efforts. For animals, Griffith *et al.* (1989) reported that success rates for the translocation of birds in the United States, Australia, Canada, and New Zealand range widely, from 10% to greater than 90%. The results depended upon the type of animal involved and the conditions of release. They concluded that without high quality habitat at the receptor site, translocations had a low chance of success, regardless of how many animals were released or the condition of the individuals. High quality receptor habitat may be even more critical for plant transplantations than for animals, because of the physical immobility of plants.

For plants, Hall (1986) recently reviewed transplantation for sensitive plants as mitigation for environmental impacts in California, and concluded that transplantation has not been a "panacea"

for botanical resource conservation. Hall also suggested that the lack of sufficient post-transplantation maintenance and monitoring has contributed to the unreliability of these mitigation techniques. Monitoring, however, is a labor-intensive commitment, and as such, may not be budgeted appropriately, particularly over the long term. In addition, monitoring of rare plant species can take many forms (see for example, Palmer 1987), and standards for monitoring should be established before mitigation successes can be compared. This is an enormous task.

The effective of many kinds mitigation-related projects is coming into question elsewhere, and it is a critical resource conservation issue for the regulatory community and the public alike. For example, the Florida Department of Environmental Regulation recently issued a report that summarized the success of wetland mitigation required for the issuance of dredge and fill permits under the state Henderson Wetlands Act of 1984 (FDER 1991). The success rate of mitigation was 27% (with some wetland types proving much less successfully mitigated than others). The report also finds that with the institution of simple remedial measures, mitigation success could have been increased to 40% overall. Interestingly, the report documented only 6% (4 out of 63) were found to be in full compliance with the mitigation requirements of the permit.

Some analogies may be relevant here. First, in both instances, success rates for mitigation projects is equal to or less than 25%. This statistic should be unacceptable to the regulating agency, and strongly indicates that the program is not working effectively. Second, some plants (as some wetland habitats) may be more easily manipulated (*i.e.*,, mitigated) than others. This is clearly reflected in the kinds of plants (*e.g.*, succulents and cacti) that were determined to be successfully mitigated in this review. Third, it is likely that with simple remedial measures (as discussed for the Florida wetlands), *e.g.*, hand-watering, weeding of competing exotics, fencing, *etc.*, mitigation success rates for the transplantation of State-listed species could be greatly enhanced. Finally, although not part of this study, it should be investigated whether the permittees are in full

compliance with the Mitigation Agreements.

There are some success stories, however. *Stephanomeria malheurensis* (Parenti and Guerrant 1990) and *Styrax texana* (Cox 1990) are two endangered plants that have been successfully reintroduced back into their native habitats in Oregon and Texas, respectively. In many instances, such as these two, success of relocation, reintroduction, or transplantation is achieved through Herculean means. Thus until we understand thoroughly the techniques of translocation, relocation, reintroduction, and restoration, it may be unwise to routinely agree to these forms of mitigation for endangered, threatened, or rare botanical resources.

In conclusion, it is recommended that because of the low success rate of the completed mitigation-related projects involving translocation, relocation, and reintroduction, and the reasonably high number of projects that are on-going and for which no conclusive information is currently available, the Endangered Plant Program should limit their Mitigation Agreements to those projects for which such techniques are the only known means of preservation of a population of an endangered, threatened, or rare species, or for impact avoidance is not possible, and for which there is no demonstrated practicable alternative.

VI. ACKNOWLEDGEMENTS

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APPENDIX A. EXAMPLE COVER LETTER AND QUESTIONNAIRE

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18 April 1990

Ms. Ann Howald, Program Ecologist
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Dear Ms. Howald:

As part of the California Department of Fish and Game's Endangered Plant Program review of mitigation for state-listed rare, threatened and endangered plant species, I am conducting a survey of mitigation, transplantation, replantation and reintroduction projects that have been implemented or planned in California. The purpose of this survey is to assess the success of mitigation-related transplantation, relocation and reintroduction projects of state-listed plant species.

The enclosed form details fifteen questions. Please answer each to the best of your knowledge. Should you need more room for your answers, please feel free to attach an additional sheet. Copies of any reports for projects of an unusual or special nature, or illustrative for any particular point, would be greatly appreciated.

If you are unable to complete this questionnaire, please contact me at your earliest convenience (415-338-6270). If you would prefer, this questionnaire can be completed by phone if you call me at a time convenient for both parties.

Thank you for your time. Your efforts are of considerable importance for a project that has significant ramifications for the future of the rare plant species of California.

Yours most sincerely,

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Appendix A

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APPENDIX C. PERSONS RESPONDING TO QUESTIONNAIRE AND SUMMARY RESPONSES

Appendix C. Persons And/Or Agencies Responding to Questionnaire and Summary Responses

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Balance Hydrologics Berkeley, CA [Contact: Barry Hecht]	*Orcuttia viscida*

[1]Never involved refers to the non-involvement of the person, agency or specific branch thereof, in a mitigation-related transplantation, relocation, or reintroduction of a state-listed endangered, threatened or rare species. The party may have been involved in the transplantation of a state- or federally-listed rare, endangered or threatened species, but the project was not related to mitigation.

[2]Mr. Amme reported that he had developed a restoration plan for the Alameda manzanita (*Arctostaphylos pallida*) for the East Bay Regional Park District, but it was never implemented.

Ellen Bauder Dept. Biological Sciences San Diego State University	Never Involved[3]
R.W. Benseler Dept. Biological Sciences California State University Hayward, CA	Never Involved
Albin Bills Department of Biology Butte College Oroville, CA	Never Involved
Charles Black Department of Biology California State University San Diego, CA	Answered with Paul Zedler; *Pogogyne abramsii,* *Eryngium aartistulatum*
Geoff Burleigh San Fernando, CA	Never Involved
California Conservation Corps Sacramento, CA [Contact: Walt Auburn]	Never Involved[4]
California Department of Fish & Game Bishop, CA [Contact: Denyse Racine]	Never Involved
California Department Fish & Game Denair, CA [Contact: Holman E. King]	Never Involved
California Department of Fish & Game Fresno, CA [Contact: Leland K. Ashford, Jr.]	Never Involved
California Department of Fish & Game Grass Valley, CA [Contact: Jeff Finn]	Never Involved[5]

[3]Dr. Bauder sent information on research-related work on San Diego vernal pools.

[4]Recommended contacting others, specifically Chris Sauer at the CCC's nursery.

[5]Mr. Finn mentioned two vernal pool creation/restoration projects near Roseville.

California Department of Fiah & Game Lodi, CA [Contact: Sandy Harrison]	Never Involved
California Department of Fish & Game Marysville, CA [Contact: Dale Whitmore]	Never Involved
California Department of Fish & Game Rancho Cordova [Contact: Response not signed]	*Lilaeopsis masonii*
California Department of Fish & Game Springville, CA [Contact: James V. Crew]	Never Involved
California Department of Fish & Game Endangered Plant Program Sacramento, CA [Contact: Ann Howald]	*Oenothera wolfii* *Sidalcea pedata*
California Department of Fish & Game San Diego, CA [Contact: Denise Racine]	Never Involved
California Department of Fish & Game Yountville, CA [Contact: Carl Wilcox]	*Lasthenia burkei*
California Department of Forestry Jackson State Forest Ft. Bragg, CA [Contact: Dana Cole]	Never Involved
California Department of Parks & Recreation Lodi, CA [Contact: Sandy Harrison]	Never Involved
California Department Parks & Recreation Monterey, CA [Contact: Jean Ferreira]	Never Involved[6]
California Department of Parks & Recreation Sacramento, CA [Contact: Frederica Bowcutt]	*Lupinus tidestromii, Lilaeopsis masonii, Chorizanthe howellii, Erysimum menziesii*
California Department of Parks & Recreation, OHMVR	

[6]Ms. Ferreira mentioned briefly a non-mitigation related project involving *Erysimum menziesii*, but did not send any information regarding the project.

Sacramento, CA [Contact: Roy Woodward]	Never Involved
California Department of Transportation Los Osos, CA [Contact: Gary Ruggerone]	Never Involved[7]
California Department of Transportation Redding, CA [Contact: Sharon Villa]	*Sedum albomarginatum*
California Department of Transportation Sacramento, CA [Contact: Craig Martz]	*Eriastrum densifolium* ssp. *sanetorum* *Sedum albopurpureum*
California Department of Transportation San Diego, CA [Contact: John Rieger]	San Diego Vernal Pool Species
California Department of Transportation San Francisco, CA [Contact: Sid Shadle]	Never Involved
California Department of Transporation Stockton, CA [Contact: Deborah McKee]	Never Involved
California Department of Water Resources Sacramento, CA [Contact: John Squires]	Recommended contacting Phil Wendt re: *Lilaeopsis masonii*
California Energy Commission Sacramento, CA [Contact: James Brownell and Rick York]	*Opuntia basilaris* ssp. *treleasei*[8] *Eriophyllum mohavense*

[7]Mr. Ruggerone sent information on the transplantation work on federal candidate species *Circium occidentale* var. *compactum* in two projects, Little Pico Bridge replacement and the Piedras Blancas shoulder widening.

[8]Neither of these species is state-listed, but *Eriophyllum mohavense* meets CEQA criteria. *Opuntia basilaris* ssp.*treleasei* is a "candidate" for state listing.

California Native Plant Society Dorothy King Young Chapter Gualala, CA	Never Involved
California State Food and Agriculture Sacramento, CA [Contact: Doug Barbe]	Never Involved
Joe Callizo St. Helena, CA	Never Involved
City of Chico Planning Office Chico, CA [Contact: Cliff Sellers]	Never Involved
Curcurt Riders Productions Windsor, CA [Contact: Rocky Thompson]	Never Involved[9]
Katherine Culligan Piedmont, CA	Never Involved
Michael Curto California Deparment of Parks & Recreation San Diego, CA	Never Involved[10]
CWESA Sanger, CA [Contact: Curt Uptain]	Never Involved
Dames & Moore Goleta, CA [Contact: John Gray]	Never Involved
Mary DeDecker Independence, CA	Never Involved
LauraMay Dempster Jepson Herbarium University of California Berkeley, CA	Never Involved
Desert Studies	

[9]Mr. Thompson sent information on a research project involving *Dichanthelium lanuginosum* ssp. *thermale*.

[10]Mr. Curto is no longer with CDPR, and sent personal comments about mitigation-related work with rare plant species.

Fullerton, CA [Contact: Alan Romspert]	Never Involved
Wendie Duron Clovis, CA	Never Involved
EA Engineering Science & Technology Lafayette, CA [Contacts: Sia Morhardt & R. Douglas Stone]	Never Involved
East Bay Regional Park District Oakland, CA [Contact: Kevin Shea]	Never Involved[11]
EIP Associates Sacramento, CA [Contact: Brian Hoffman]	Never Involved
Envicom Corporation Calabasas, CA [Contact: Carl Wishner]	*Pentachaeta lyonii*
Envirosphere Co. Culver City, CA [Contact: David Bradford]	Never Involved
Phyllis Faber Mill Valley, CA	Never Involved
Roman Gankin Redwood City, CA	Never Involved
GENREC Oakland, CA [Contact: Larry Riggs]	Never Involved
Betty & Jack Guggolz Cloverdale, CA	Never Involved
GW Consulting Engineers Citrus Heights, CA [Contact: Jerry Anders]	Never Involved
Nancy Harrison Dept. Life Sciences Santa Rosa Junior College Santa Rosa, CA	Never Involved

[11]Mr. Shea sent non-mitigation related information concerning a research project on *Amsinkia grandiflora* conducted in the EBRPD.

Larry Heckert Jepson Herbarium University of California Berkeley, CA	*Cordylanthus palmatus* *Castilleja uliginosa*
Mary Ann Henry Ridgecrest, CA	Never Involved[12]
Doris A. Hoover Woodland Hills, CA	Never Involved[13]
Barbara Hopper Kenwood, CA	Never Involved
Hydrozoology Newcastle, CA [Contact: Wayne Fields]	Never Involved
J & M Land Restoration Bakersfield, CA [Contact: Diane Mitchell]	Never Involved
Dave Keil Department of Biological Sciences California Polytechnic Institute San Luis Obispo, CA	Never Involved
David B. Kelley Sacramento, CA	Never Involved

[12]Ms. Henry sent comments about her concern over *Eriophyllum mohavense* as potentially threatened.

[13]Never involved in a transplantation, reintroduction or relocation project, but sent information on non-mitigation-related restoration project for *Hemizonia minthornii* and *Dudleya cymosa* ssp. *marcescens*

Kleinfelder Walnut Creek, CA [Contact: Charles G. Wolfe]	Never Involved
L & M Land Restoration Bakersfield, CA [Contact: Diane Mitchell]	Never Involved
Leitner Biological Consulting Oakland, CA [Contact: Barbara Leitner]	Never Involved
The Living Desert Palm Desert, CA [Contact: Jon Mark Stewart]	Never Involved
Los Angeles Department of Water & Power Bishop, CA [Contact: Patti Novak]	Never Involved
Joe McBride Department of Forestry & Resource Management University of California, Berkeley	Never Involved
Niall McCarten Department of Integrative Biology University of California, Berkeley	*Lilaeopsis masonii*
Elizabeth McClintock San Francisco, CA	Never Involved
Malcolm McLeod Dept. Biological Sciences California Polytechnic Institute San Luis Obispo, CA	Never Involved
Dale McNeal Dept. of Biology University of the Pacific Stockton, CA	Never Involved
Jack Major Dept. of Botany University of California, Davis	Never Involved
Jerry Meral Planning & Conservation League Sacramento, CA	Never Involved
Rhonda & Carl Meyers McKinleyville, CA	Never Involved

Maynard Moe Dept. Biology California State University Bakersfield, CA	Never Involved
Gilbert Muth Biology Department Pacific Union College Angwin, CA	Never Involved
Mycorrhizal Services Menifee, CA [Contact: Theodore St. John]	Never Involved
Pacific Gas and Electric Company Department of Engineering Research San Ramon, CA [Contact: Sally deBecker]	Never Involved
Pacific Gas and Electric Company San Francisco, CA [Contact: Frank Chan; Ken DiVittorio]	Never Involved
Pacific Southwest Biological Services, Inc. National City, CA [Contact: Mitchel Beauchamp]	Refused to Answer
V.T. Parker Department of Biology San Francisco State University	Never Involved
Charlie Patterson El Cerrito, CA	*Lasthenia burkei*, *Blennosperma bakeri*
Phillip Williams & Associates San Francisco, CA [Contact: Bob Coats]	Never Involved
Placer County Community Development Dept. Auburn, CA [Contact: Thomas Kubik]	Never Involved
Planning Associates Redding, CA [Contact: Don Burke]	Never Involved[14]

[14]Recommended contacting Dr. Kingsley Stern at Chico State regarding *Orcuttia tenuis*.

Bob Powell Davis, CA	Never Involved
Rancho Santa Ana Botanical Garden Claremento, CA [Contact: Orlando Mistretta]	Indirectly Involved[15]
Thomas Reid Associates Palo Alto, CA [Contact: Taylor Peterson]	Never Involved[16]
Peter Rubtzoff San Francisco, CA	Never Involved
Jake Ruygt Napa, CA	Never Involved
City of Sacramento Planning Dept. Sacramento, CA [Contact: Holly Keeler]	Never Involved[17]
Sacramento County Dept. of Parks and Recreation Sacramento, CA [Contact: Steve Flannery]	Never Involved
Sacramento County Environmental Impact Section [Contact: Doug Peterson]	Never Involved

[15]Provided nursery stock of *Pentachaeta lyonii* to Envicom Corporation, *Acanthomintha ilicifolia* to ERCE, *Cercocarpus traskiae* to the Catalina Island Conservancy, and *Eriastrum densifolium* ssp. *sanctorum* to the U.S. Bureau of Land Management.

[16]Firm was not involved in any transplantation, reintroduction or relocation projects for State-listed species, but did devise a plan for *Castilleja neglecta* that was never implemented due to project postponement.

[17]Ms. Keeler recommended contacting the consulting firm Zentner and Zentner regarding the Laguna Creek Project.

Sacramento County Planning Department [Contact: Robert Burness]	Never Involved
City of San Diego [Contact: Keith A. Greer]	*Monardella linoides* ssp. *viminea*; *Eryngium aristulatum* var. *parishii*[18]
San Diego Department of Public Works San Diego, CA [Contact: Maggie Loy]	Never Involved
Santa Barbara County Santa Barbara, CA [Contact: John Storrer]	*Hemizonia increscens* ssp. *villosa*
City of Santa Rosa [Contact: Denise Peters]	Responded; see Sonoma County Planning Dept.
John Sawyer Biology Department Humbolt State University Arcata, CA	*Erysimum menziesii* *Lilium occidentale*
Marie Simovich Biology Department University of San Diego	Never Involved
James P. Smith, Jr. Dept. Biological Sciences Humbolt State University Arcata, CA	Never Involved
Susan Smith San Francisco, CA	Never Involved
Solano County/ Environmental Management Fairfield, CA [Contact: Karen Wyeth & Cynthia Copeland]	Never Involved
Sonoma County Planning Dept. Santa Rosa, CA [Contact: Ken Milam]	Santa Rosa Plains Vernal Pools

[18]Mr. Greer also sent information for several other plant species that are not state-listed, but have some form of federal status.

Siskiyou County Dept. Agriculture Montague, CA [Contact: Bill Ferlatte]	*Calochortus greenei*
Sonoma State Botanical Garden Sebastopol, CA [Contact: Karen Tatanish]	Never Involved
Sonoma County Planning Department Santa Rosa, CA [Contact: Ken Milam]	*Navarretia plieantha* *Limnanthes vinculans* *Lasthenia burkei*
Stanford University Jasper Ridge Biological Preserve [Contact: Alan Grundman]	Never Involved
John Stebbins Clovis, CA	*Pseudobahia peirsonii*, *Brodiaea insignis*
Sugnet & Associates Roseville [Contact: John Ranlett]	Never Involved
The Nature Conservancy San Francisco, CA [Contact: Robin Cox & Leslie Friedman]	Never Involved
The Nature Conservancy Santa Barbara, CA Peter Schuyler	Never Involved[19]
Tierra Madre Consultants Riverside, CA [Contact: Larry LaPre]	Never Involved[20]

[19]Mr. Schuyler is no longer with The Nature Conservancy.

[20]Tierra Madre Consultants is planning projects that involve the mitigation-related manipulation of *Brodiaea filifolia* and *Eriastrum densifolium* ssp. *sanctorum*.

Tree of Life Nursery San Juan Capistrano, CA [Contact: Mike Evans]	Indirectly Involved[21]
Trust For Public Land San Francisco, CA [Contact: Bennett Johnston]	Never Involved
Tulare County Planning Visalia, CA [Contact: Hector Guerro]	Never Involved
Tuolumne County Planning Dept. Sonora, CA [Contact: John Anderson]	Never Involved
U.S. Army Corps of Engineers Sacramento, CA [Contact: Larry Vinzant]	Never Involved
U.S. Bureau of Land Management Arcata, CA [Contact: Carol Tyson & Steve Hawks]	Never Involved
U.S. Bureau of Land Management Folsom, CA [Contact: D.K. Swickard]	Never Involved
U.S. Department of Energy Sacramento, CA [Contact: No name forwarded on questionnaire]	Never Involved
U.S. Bureau of Land Management Riverside, CA [Contact: Gerald Hillier & Connie Rutherford]	*Croton wigginsii*
U.S. Bureau of Land Management Susanville, CA [Contact: Gary Schoolcraft]	*Antennaria flagellaris*

[21]Mr. Evans forwarded a list of rare, endangered and threatened plants handled by Tree of Life Nursery. State-listed species include: *Acanthomintha ilicifolia, Arctostaphylos imbricata, Brodiaea filifolia, Ceanothus heastiorum, Ceanothus maritimus, Eriastrum densifolium* ssp. *sanctorum, Eriogonum crocatum, Fremontodendron mexicanum, Hemizonia minthornii, Mahonia nevinii, Malacothamnus clementinus,* and *Monardella linoides* ssp. *viminea.*

U.S. Bureau of Land Management Ukiah, CA [Contact: Pardee Bardwell]	*Arabis macdonaldiana* Contracted with M. Baad
U.S. Fish and Wildlife Service San Francisco Bay Wildlife Refuge Complex Newark, CA [Contact: Joy Albertson]	*Erysimum capitatum* var. *angustifolium* ,*Oenothera deltoides* ssp. *howellii*
U.S. Forest Service Alpine, CA [Contact: Maribeth Kottman]	Never Involved
U.S. Forest Service Klamath National Forest Yreka, CA [Contact: Barbara Williams]	*Calochortus greenei*
U.S. Forest Service Lake Tahoe Basin Mgmt. Unit S. Lake Tahoe, CA [Contact: Helen Soderberg]	Never Involved[22]
U.S. Forest Service Modoc National Forest Tulelake, CA [Contact: Laura Thompson]	Never Involved
U.S. Forest Service Pacific Southwest Forest & Range Experiment Station Berkeley, CA [Contact: Connie Millar]	Never Involved
U.S. Forest Service Six Rivers National Forest Eureka, CA [Contact: Dave Imper]	*Bensoniella oregana, Oenothera wolfii*
U.S. National Park Service Channel Island NP Ventura, CA [Contact: Karen Danielson & William Halvorsen]	Never Involved

[22]Never involved in a mitigation-related transplantation, reintroduction or relocation project, but mentioned that the USFS had reintroduced *Rorippa subumbellata* to three historic locations. No additional information was received.

U.S. National Park Service Golden Gate National Recreation Area San Francisco, CA [Contact: Terri Thomas]	*Arctostaphylos hookeri* var. *ravenii*
U.S. National Park Service Yosemite National Park Yosemite, CA [Contact: Susan Buis]	Never Involved
U.S. National Park Service Monterey, CA [Contact: Robert Branson]	Never Involved
U.S. Navy Public Works Dept. San Diego, CA [Contact: Mike E. Scott]	Never Involved[23]
U.S. Soil Conservation Service Sacramento, CA [Contact: Jack Wright]	Never Involved
University of California Botanical Garden Berkeley, CA [Contact: Holly Forbes]	Never Involved
University of California Hastings Natural History Reservation Carmel Valley, CA [Contact: Susan Schettler]	Never Involved
University of California James San Jacinto Mtms. Reserve Idyllwild, CA [Contact: Michael Hamilton]	Never Involved
University of California Natural Reserves System Oakland, CA [Contact: Norden H. Cheatham]	Never Involved
WESCO Novato, CA [Contact: Diane Hickson]	*Lasthenia burkei*
Western Area Power Administration	

[23]Mr. Scott recommended contacting Zentner and Zentner regarding Miramar.

Sacramento, CA [Contact: Nancy Weintraub]	Never Involved
Williams Enterprises, Inc. Seattle, WA [Contact: Mike Williams]	Never Involved
Vernal Yadon Pacific Grove, CA	Never Involved
Yolo County Resource Conservation District Winters, CA [Contact: John Anderson]	Never Involved
Paul Zedler Department of Biology San Diego State University	Answered with C.A. Black; *Pogogyne abramsii &* *Eryngium aristulatum*
John Zenter Zentner & Zentner Walnut Creek, CA	Called; Never received information on several projects involving *Gratiola heterosepala, Sagittaria sanfordii & Hibiscus californicus*