

U.S. Army Corps of Engineers Permitting and Mitigation of Central Valley Vernal Pool Impacts, 2000–2006



Prepared for:
Placer Land Trust

Prepared by:
AECOM

With Assistance from:
Vollmar Consulting

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Valley Vernal Pool Impacts, 2000–2006

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SUMMARY

In California's Central Valley vernal pools have been negatively affected by, and continue to be threatened by, urban and agricultural development. The primary objective of this study was to determine vernal pool habitat loss authorized by the U.S. Army Corps of Engineers (USACE), a government agency with regulatory authority over vernal pool habitat, and to assess the amount and effectiveness of mitigation dedicated to compensate for vernal pool habitat loss. We obtained and examined 142 USACE files for permits issued between 2000 and 2006. For each file, the amount of affected vernal pool habitat, affected species, mitigation acreages and methods, location of project, and a variety of other data were determined. Review of these permit files indicated that (1) USACE permit files generally do not contain information sufficient to fully analyze vernal pool cumulative impacts, although recent files are more complete than pre-2004 files; (2) vernal pool acreage is being replaced at a 1:1 ratio and preserved at a 2:1 ratio; however, localized net losses of vernal pool and surrounding grassland habitat have occurred in some areas; (3) mitigation banks or other off-site locations are most frequently used for mitigation, but more data are needed to assess the degree to which mitigation efforts have been successful; and (4) changes to the USACE's record-keeping procedures are needed; and (5) additional research on the performance of mitigation areas is needed to allow a full assessment of the conservation of vernal pool ecosystems.

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INTRODUCTION

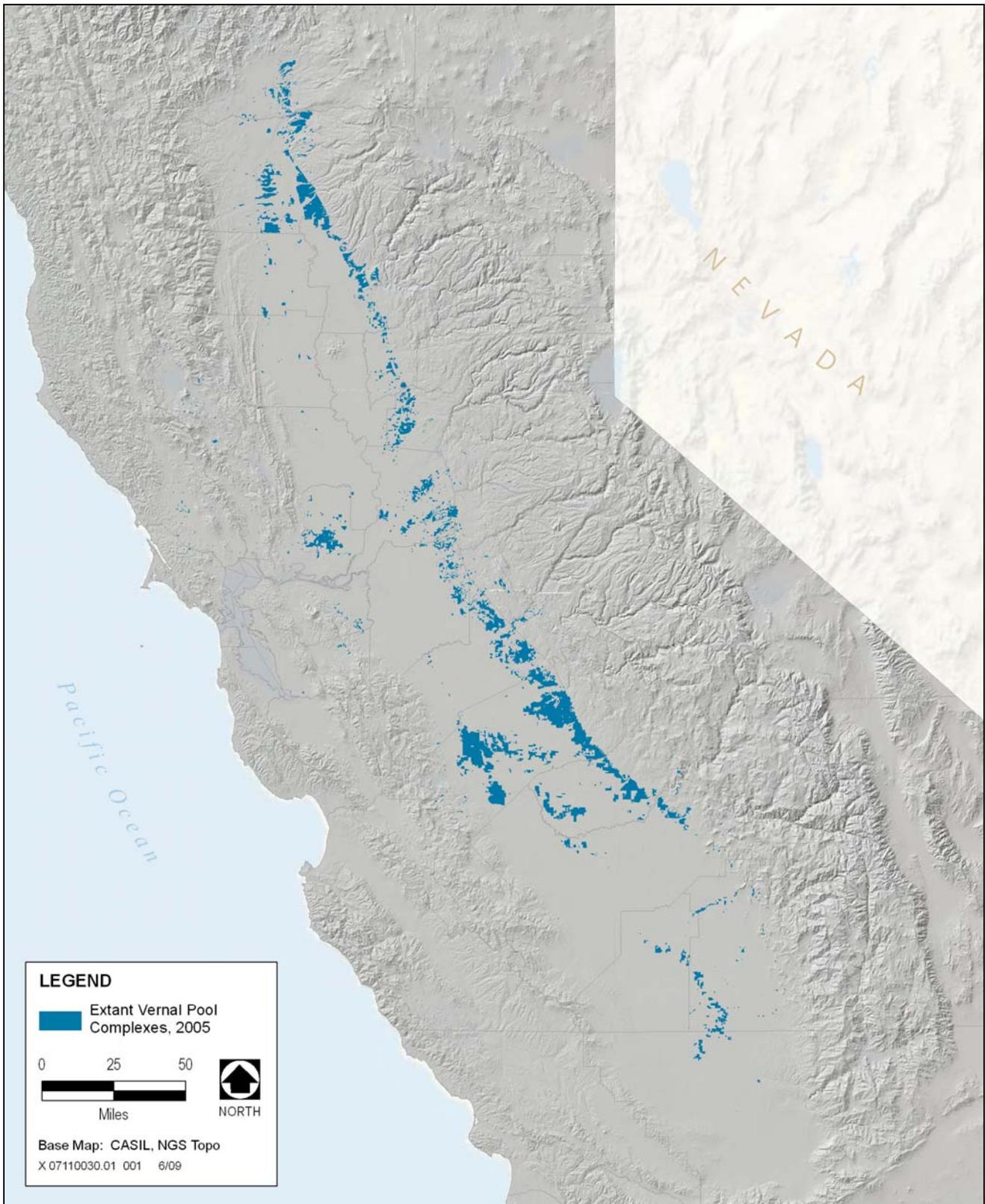
Vernal pools are one of California's unique habitats and one of its most threatened. Although ecosystems similar to vernal pools are found globally in Mediterranean climates and occasionally in other climatic zones (Keeley and Zedler 1998), the combination of an extensive endemic flora and fauna distinguishes Californian vernal pools from similar habitats worldwide (Keeley and Zedler 1998, Simovich 1998). The majority of vernal pool grassland has, historically, been used for livestock grazing, and some researchers have shown that vernal pools may benefit from some level of domestic livestock grazing to reduce build-up of nonnative grasses within and surrounding the pools (Barry 1998, Marty 2005). Much of this habitat has been lost to agricultural conversion (i.e., the conversion of rangeland to various forms of intensive agriculture), urban development, and other intensive land uses. The total amount of this loss has been estimated to be at least 75% of the historically extant habitat (Holland 1978). As a result of habitat loss, 33 species of vernal pool-dependent plants and animals (some of which are narrowly restricted endemics) have been placed on the California or federal endangered species list or both or are candidates for listing (U.S. Fish and Wildlife Service 2005). Distinctive vernal pool plant communities are also increasingly recognized as rare and limited in geographic extent, increasing the importance of local efforts to conserve the full array of plant community diversity found in vernal pools (Barbour et al. 2007).

Along with the loss of sensitive species habitat and distinct plant communities, the loss of vernal pools and the surrounding grassland matrix has potentially negative consequences for a variety of more common wildlife (Silveria 1998), various species of oligolectic Andrenid bees (Thorp and Leong 1998), and a variety of general watershed functions (e.g., attenuation of flood flows, water quality improvement) (e.g., Rains et al. 2006). Given the increasing rarity and ecological importance of vernal pools and the surrounding grassland matrix in which vernal pools occur (i.e., vernal pool grasslands), an understanding of the mechanisms by which vernal pool loss is permitted by regulatory agencies and the spatial distribution of vernal pool loss, along with the measures required by regulatory agencies to mitigate the loss of habitat, is critically important to ongoing conservation efforts.

Despite the importance of permitting and mitigation for vernal pool conservation, information on the effects of these practices is generally lacking. A series of studies (Holland 1998a, 1998b, 2009) has examined vernal pool grassland loss throughout the Central Valley via a time-series comparison of GIS-based maps. These analyses have shown that roughly 137,000 acres of vernal pool grassland have been lost throughout the Central Valley as of 2005 (Holland 2009). This loss is relative to a defined starting year that varies from county to county and ranges from the late 1970s to early 1990s. Therefore, this loss represents a period of roughly 10–30 years (Holland 2009). Vernal pool habitat that remained in 2005 is shown in Figure 1. These studies have also illustrated, in a general sense, where vernal pool grassland has been lost and, with the most recent update, why vernal pool grassland has been lost. Most of the vernal pool grassland was lost because of conversion of range land to agricultural land, which, without a permit, is in violation of the Clean Water Act when the establishment of the new farming practice reduces the extent of wetland or other waters of the United States, or causes impairment of flow or circulation in wetlands or other waters of the United States (Clean Water Act, Section 404(f)(2)). Dr. Holland's mapping efforts have not examined the underlying mechanisms by which the loss has been permitted, nor have they examined how the loss of vernal pool grassland has been compensated for and whether the compensation fully mitigated the habitat that was lost.

Data maintained by U.S. Army Corps of Engineers (USACE), specifically the USACE Regulatory Branch Sacramento, California, district office (where most permits to fill vernal pools were issued), can be used to answer these remaining questions and provide a more complete assessment of vernal pool loss and compensation¹. USACE regulates the placement of dredged or fill material into waters of the United States under Section 404 of the Clean Water Act. Waters of the United States include lakes, streams, and their tributaries and adjacent

¹ Although other data may have been useful in answering many of these questions, the intent of this study was to focus solely on USACE permit files since the USACE is the primary agency that regulates the loss of vernal pools.



Source: Holland 2009

Distribution of vernal pool habitat in California's Central Valley in 2005 obtained by Dr. Robert F. Holland by interpretation of aerial photography of the National Agriculture Imagery Program Exhibit 1

wetlands. Wetlands are defined under Section 404 as areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support (and under normal circumstances do support) a prevalence of vegetation typically adapted to life in saturated soil conditions.

Vernal pools that meet this criterion typically are regulated by USACE. The Section 404 permitting process often triggers project review under the National Environmental Policy Act (NEPA), formal consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the federal Endangered Species Act (ESA), preparation of a habitat mitigation and monitoring plan and a long-term habitat management plan, sensitive species surveys, monitoring reports, and similar environmental studies and documentation. This information is received by USACE, maintained in its permit files, and consulted when determining whether a wetlands fill permit should be issued and the amount and type of mitigation that should be required. The USACE does not have a required list of documents that must accompany a permit application; however, for larger projects typically affecting over 0.5 acre of wetlands, the issuance of a wetlands fill permit requires public notice, NEPA compliance, and federal ESA Section 7 compliance. Additional information and supporting documentation is required at the discretion of the USACE project manager processing the permit application. If losses to vernal pools and other wetland habitats are permitted by the USACE, compensatory mitigation in the form of both the creation or restoration of wetlands and the preservation of existing wetlands is required to satisfy the USACE's policy of "no net loss" of wetland functions and values. Because vernal pools are frequently considered to be habitat for species listed as threatened or endangered under the federal ESA, the USFWS also requires compensatory mitigation for vernal pool loss. In these cases, the USACE often defers to USFWS mitigation requirements and incorporates these requirements into the vernal pool mitigation requirements specified in the USACE permit. Mitigation requirements vary on a project-by-project basis and are determined by considering the quality of vernal habitat to be affected, the presence of federally-listed species and the rarity of those species, and the quality of habitat proposed as mitigation. Mitigation may occur in the same county as the affected vernal pools or in a geographically proximate county or counties.

Other researchers have reviewed USACE permitting files to quantify wetland impacts (e.g., Holland and Kentula 1992, Kentula et al. 1992, Stein and Ambrose 1998). Generally, these studies have found that USACE permitting files lack sufficiently detailed information to conclusively answer many questions related to the amount of wetland habitat loss and accompanying mitigation measures. Still other researchers have commented on the limitations of compensatory wetland mitigation in general and recommended revisions to the USACE permitting process that would help to ensure that compensatory mitigation more faithfully replicates the ecological functions and values of the habitats for which loss has been permitted (Race and Fonseca 1996, Ambrose 2000, National Research Council 2001). A recent study (U.S. Government Accountability Office 2009) found that USFWS similarly lacked the information required to assess the cumulative impacts of the biological opinions it issues under Section 7 of the ESA and recommended changes to USFWS record-keeping procedures to better track the loss of habitat for many federally listed species of plants and animals.

The current study reviews the USACE permitting and mitigation process specifically as it applies to vernal pools. It attempts to answer a series of questions to obtain a better understanding of the USACE Section 404 permitting process specific to vernal pools, the amount of vernal pool habitat loss resulting from this process (including both vernal pool wetlands and surrounding grassland habitat), and the amount and type of mitigation intended to compensate for this loss. The specific questions are as follows:

Permitting Process

1. What documents are typically contained in a USACE individual permit file, and what is the distribution of these documents across all permit files?
2. For what percentage of projects are protocol-level surveys for federally listed species conducted? For what percentage is the presence of listed species assumed?

Vernal Pool Loss

1. How are projects distributed (both in terms of absolute numbers and total acres of vernal pool grassland) across the Central Valley?
2. How many acres of vernal pools and other wetlands are found on each project site?
3. How much vernal pool and other wetland acreage loss is permitted for each project, and what percentage of the total project site wetland acreage does it represent?

Vernal Pool Mitigation

1. How much mitigation is required for vernal pools and other wetlands? How much acreage is required to be preserved versus created or restored? How does the amount of required mitigation compare to the amount of permitted loss?
2. How are mitigation requirements satisfied? How many projects use on-site mitigation, off-site mitigation, mitigation/conservation banks, and the in-lieu fee, and how many acres of vernal pools and other wetlands are mitigated by each method?
3. Where are mitigation sites located, and how do key physical and biological characteristics (e.g., total vernal pool grassland acreage, wetland acreage and diversity, distribution of landforms) differ between mitigation and project sites?
4. What entities typically own, manage, and/or hold a conservation easement on mitigation areas?

The answers to these questions will provide a more complete picture of the vernal pool permitting and mitigation process.

METHODS

The project study area included those portions of the Central Valley under the jurisdiction of USACE's Sacramento District (i.e., all or part of the following California counties: Shasta, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Yolo, Sacramento, Placer, El Dorado, San Joaquin, Amador, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, Kern, Solano, and Contra Costa).

Vernal pool impacts and required mitigation associated with projects in these counties were analyzed by reviewing USACE Section 404 permit files obtained through Freedom of Information Act (FOIA) requests. The following steps were employed to gather USACE permit files.

DATA COLLECTION

A list of permits that had been issued for the fill of vernal pools and similar wetlands was requested from the regulatory branch of the Sacramento District of USACE. Unfortunately, USACE does not track permits by the type of wetland for which fill was requested and permitted. If USACE initiates consultation with USFWS under Section 7 of the ESA as part of its permitting process, however, it tracks the species for which consultation was sought. Although USACE does not consistently enter data into this field when logging permit records to its database (Cavanaugh, pers. comm., 2007), querying this field was believed to be the only way to identify permits for vernal pool fill and exclude permits issued for other wetland types, which were of no interest in the current study. USACE was therefore provided with a list of species to query from its database (Table 1). It was further asked to supply permit numbers only for projects occurring in the 22-county Central Valley study area. This initial request yielded a list of 181 unique permit numbers meeting both the species and geographic criteria.

Because the number of permits issued by USACE between 2000 and 2006 for the discharge of fill into vernal pools was likely greater than 181, a list of permit numbers from the USFWS Sacramento endangered species branch also was requested. To extract only the records of interest, the USFWS database was queried for records where:

- ▶ the Sacramento District of USACE requested consultation under Section 7 of the ESA,
- ▶ the project fell within the study’s 22-county Central Valley study area,
- ▶ a no jeopardy biological opinion (BO) was issued, and
- ▶ the USACE permit number appeared valid.

This query identified 233 unique permits meeting the specified criteria.

Table 1	
Central Valley vernal pool species that are listed as threatened or endangered, that were queried from the U.S. Army Corps of Engineers wetland permit database to obtain permits issued for projects that may have affect vernal pools	
Scientific Name	Common Name
<i>Ambystoma californiense</i>	California tiger salamander
<i>Elaphrus viridis</i>	Delta green ground beetle
<i>Branchinecta longiantenna</i>	longhorn fairy shrimp
<i>Branchinecta conservatio</i>	Conservancy fairy shrimp
<i>Branchinecta lynchi</i>	vernal pool fairy shrimp
<i>Lepidurus packardi</i>	vernal pool tadpole shrimp
<i>Neostapfia colusana</i>	Colusa grass
<i>Orcuttia inaequalis</i>	San Joaquin Valley Orcutt grass
<i>Orcuttia pilosa</i>	hairy Orcutt grass
<i>Orcuttia viscida</i>	Sacramento Orcutt grass
<i>Orcuttia tenuis</i>	slender Orcutt grass
<i>Tuctoria mucronata</i>	Solano grass
<i>Tuctoria greenei</i>	Greene’s tuctoria
<i>Castilleja campestris</i> ssp. <i>succulenta</i>	succulent owl’s clover
<i>Chamaesyce hooveri</i>	Hoover’s spurge
<i>Limnanthes floccosa</i> ssp. <i>californica</i>	Butte County meadowfoam
<i>Lasthenia conjugens</i>	Contra Costa goldfields

Source: Data provided by AECOM in 2009

The 181 permit numbers obtained from the USACE database and 233 permit numbers obtained from the USFWS database were combined into a single list. Review of the combined list of permit numbers revealed that permits for some projects were still missing. (Project team members had personal knowledge of these permits from past experience.) A review of the USFWS database revealed that the projects that had not been identified through the database queries had undergone Section 7 consultation with a federal agency that was not USACE (e.g., the U.S. Air Force or the Federal Highway Administration) acting as the lead agency for consultation with USFWS. After these permits were manually added into the database and duplicate permit numbers were removed, the permit database contained 307 unique USACE permit numbers.

Twenty permits were randomly selected to test the FOIA process and the time required to process each file. A review of these files, which included a variety of permit types, revealed that nationwide permits (i.e., permits usually issued for less than 0.5 acre of wetland impacts) rarely contained a significant amount of information relevant to the current study and frequently took nearly as long to process as permit files for larger projects. Therefore, all permits that were determined to be nationwide permits, with the exception of Nationwide Permit 26, were eliminated from the FOIA process, yielding 159 USACE permit numbers. Prior to expiring on February 14, 2000, Nationwide Permit 26 was frequently issued for wetland impacts greater than 0.5 acre and was, therefore, retained in our study permit population.

Before FOIA requests were submitted to USACE, project records with erroneous USACE permit numbers that could not be corrected and mitigation and conservation bank developments were excluded from the final list. After these project records were removed, the final project master permit database contained 142 unique USACE permit numbers.

Freedom of Information Act requests were submitted to USACE from December 2007 through March 2009. USACE provided photocopies of each permit file. All permit file documents were scanned and saved in Adobe PDF with text search capabilities. Each permit file was manually reviewed, and relevant data were entered into a relational database to facilitate storage, retrieval, and analysis of permit file data. Data fields entered from each permit file are provided in Table 2.

Table 2 Contents of the database created for data from USACE permit files on Central Valley projects affecting vernal pools	
Data Field	Contents
Project Attributes	Name, acreage, proponent, city, county, location, project site wetland acreage by wetland type, alternate names used for project or project proponent
Permit File Contents	Name, date, and preparer of all documents found in USACE permit file
Special-Status Species	Species name, whether surveys were conducted or species presence was assumed, date of surveys, individual or firm conducting surveys, results of surveys, whether or not Section 7 consultation was initiated
Permit Data	USACE permit number and USFWS BO number, status of the permit and BO (i.e., issued, denied, or in progress), date the documents were issued, type of USACE permit issued and nationwide permit number (if applicable), whether the BO was issued under the USFWS programmatic BO for projects with small effects on listed vernal pool crustaceans (BO # 1-1-96-F-1), amount of loss permitted (by wetland type) by the USACE permit and BO and required mitigation acreage
Mitigation Data	How mitigation was provided (bank, on-site, off-site, or in-lieu fee), name and location of mitigation site, acreage of mitigation provided at each site, selected mitigation site attributes (total acreage, wetland acreage, site owner, site manager, conservation easement holder, endowment amount, and types of monitoring data collected for the site)
Notes: BO = biological opinion; USACE = U.S. Army Corps of Engineers; USFWS = U.S. Fish and Wildlife Service. Source: Data provided by AECOM in 2009	

GIS DATABASE CREATION

Project and corresponding mitigation area boundaries were mapped in ArcGIS from maps contained in the USACE permit file. Where needed, parcel maps, 2005 National Agricultural Imagery Program color aerial photographs, and other background data sources were used to properly locate site boundaries. Both project site boundaries and mitigation site boundaries were mapped as polygons.

A GIS-based analysis of vernal pool landform distributions among project sites and mitigation areas was conducted. To facilitate this analysis, a Central Valley-wide soils database was created from GIS-format soils maps readily available from the U.S. Natural Resources Conservation Service Soil Survey Geographic Database (2009). Each soil mapping unit was correlated to a specific vernal pool landform using Smith and Verrill (1998).

RESULTS

Of the 142 permit files requested from USACE, 111 final issued permits were received. Two of the permits were denied by USACE, five permits were missing (i.e., USACE could not locate the files), and final USACE permits were not received for 24 of the requested files. While several possible reasons may account for the lack of receipt of a final permit, the most likely causes include: the permit application was withdrawn; the permit application was still in process with the USACE; or, the USACE project manager neglected to place the final permit in the file. The sample size was further reduced because 42 of the remaining 111 permits were nationwide and not individual permits (despite efforts to identify nationwide permits and exclude them from FOIA requests). Finally, issuance of five of the 69 individual permits that were received did not result in fill of vernal pools. Therefore, the results presented below represent 64 individual permits issued between 2000 and 2006. Issuance of each of these permits resulted in the loss of some vernal pool acreage.

PERMITTING PROCESS

Most permit files contained both a copy of the final USACE permit (along with associated NEPA compliance and public notice documents) and the final BO. However, many other documents were missing or found only sporadically. The missing documents would have provided more detailed information on biological impacts associated with the projects and on required mitigation measures. A breakdown of permit file contents is shown in Table 3. Permit file contents were further analyzed by the year in which the permit was issued to determine whether the percentage of various documents in the permit files changed over the duration of the study period. As shown in Table 4, recent permit files (arbitrarily defined as permits issued between 2004 and 2006) more frequently contained a wider variety of documents. In particular, the more recent files more often included the mitigation and monitoring plan, habitat management plan, and public notice documents.

Table 3
Contents of 64 files for individual permits issued by the USACE for
Central Valley projects that affect vernal pools

Document	Number of Files	Percent of Files
USACE permit	64	100
USFWS BO	60	94
Evaluation and decision document	51	80
Public notice	50	78
Wetland delineation	43	67
Mitigation and monitoring plan	35	55
Habitat management plan	31	48
Biological assessment	22	34

Notes: BO = biological opinion; USACE = U.S. Army Corps of Engineers; USFWS = U.S. Fish and Wildlife Service.
 Source: Data provided by AECOM in 2009

Table 4
Permit file contents for Central Valley projects that affect vernal pools for permits issued in the years 2000–2004 and 2004–2006

Document	2000–2004		2004–2006	
	Number of Files	Percent of Files	Number of Files	Percent of Files
USACE permit	25	100	39	100
USFWS BO	25	100	35	90
Evaluation and decision document	18	72	33	85
Public notice	15	60	35	90
Wetland delineation	14	56	29	74
Mitigation and monitoring plan	8	32	27	69
Habitat management plan	7	28	24	62
Biological assessment	6	24	16	41

Notes: BO = biological opinion; USACE = U.S. Army Corps of Engineers; USFWS = U.S. Fish and Wildlife Service.
Source: Data provided by AECOM in 2009

Many project applicants assumed that listed vernal pool species were present on their project sites and chose not to conduct protocol-level surveys to demonstrate presence or absence of listed species. A total of 136 instances of federally listed vernal pool species were either known to occur or had the potential to occur in the 64 study projects (Table 5). Vernal pool branchiopods, particularly vernal pool fairy shrimp (*Branchinecta lynchi*) and vernal pool tadpole shrimp (*Lepidurus packardii*), were the most frequently encountered species on project sites. In most instances (65% and 69%, respectively) the presence of these two species was assumed and surveys were not conducted. When surveys were conducted, these species were often found, particularly vernal pool fairy shrimp, which was found in approximately 59% of the cases for which surveys were conducted.

Table 5
Federally listed threatened or endangered species that are addressed in 64 USACE permit files for Central Valley projects that affect vernal pools

Species	Number of Project Sites on Which Species Was Known to Occur or Had Potential to Occur	Number of Surveys Conducted for Species	Number of Times Species Located
<i>Branchinecta lynchi</i>	63	22	13
<i>Lepidurus packardii</i>	61	19	6
<i>Orcuttia viscida</i>	3	3	0
<i>Orcuttia tenuis</i>	2	2	0
<i>Limnanthes floccosa ssp. californica</i>	2	2	1
<i>Ambystoma californiense</i>	2	2	1
<i>Branchinecta conservatio</i>	1	0	--
<i>Elaphrus viridis</i>	1	1	0
<i>Branchinecta longiantenna</i>	1	1	0

Source: Data provided by AECOM in 2009

VERNAL POOL LOSS

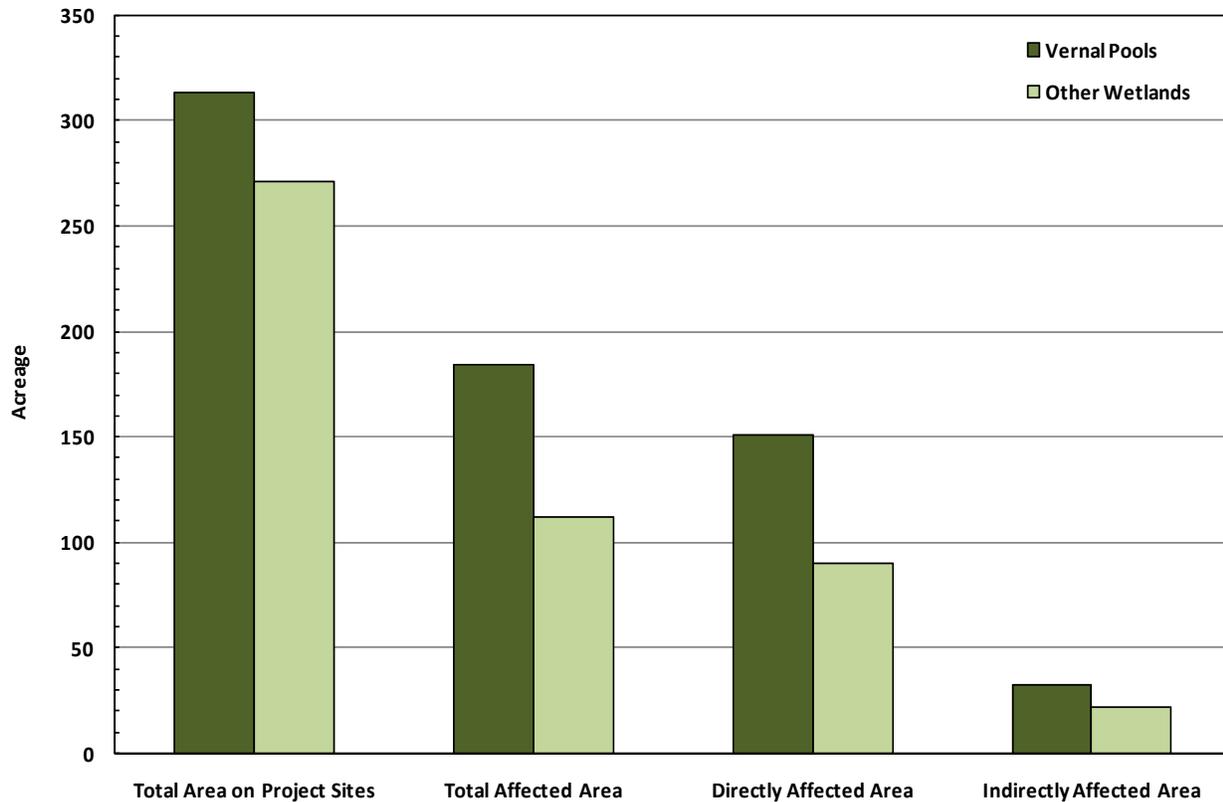
To better understand how and where vernal pool loss occurred, the total acreage for permitted projects (i.e., the total acreage of vernal pool grassland), the distribution of these projects across the Central Valley, the total wetland acreage on permitted project sites, and the total acres of wetland loss permitted were examined. A subset of the 64 projects was used because several of the permit files did not contain data sufficient to conduct the analysis. The number of projects that were analyzed in answering each question is specified below.

The vast majority of permitted vernal pool grassland loss has been concentrated in Sacramento and Placer Counties, with roughly 72% of the total project site acreage and 75% of the permitted projects found in these two counties (n = 57) (Table 6). Approximately 584 acres of wetlands, roughly 54% of which was vernal pools and 46% other wetlands and waters (e.g., drainages, permanent ponds), were found within the 16,916 acres of vernal pool grassland for which Section 404 permits were issued (n = 53) (Figure 2). Direct (i.e., discharge of fill into the wetland) or indirect (i.e., impairment of wetland functions and values but no fill discharge) effects were permitted to roughly 58% of the vernal pools found on these 53 project sites, and direct effects to vernal pools was the most commonly permitted type of wetland impact. Indirect effects on vernal pools and effects on other types of

Table 6
Project site area (in acres) of Central Valley counties for 54 projects that received USACE individual permits issued between 2000 and 2006 for placing fill in vernal pools

County	Number of Projects	Total Area (acres)	Average Size (acres)
Placer	13	7,448	572
Sacramento	30	4,708	157
Solano	3	1,787	596
Shasta	3	948	316
Fresno	1	765	765
Butte	4	541	135
Contra Costa	1	481	481
Amador	1	182	182
Yuba	1	25	25
Total or average	54	16,915	304

Source: Data provided by AECOM in 2009



Source: Data provided by AECOM in 2009

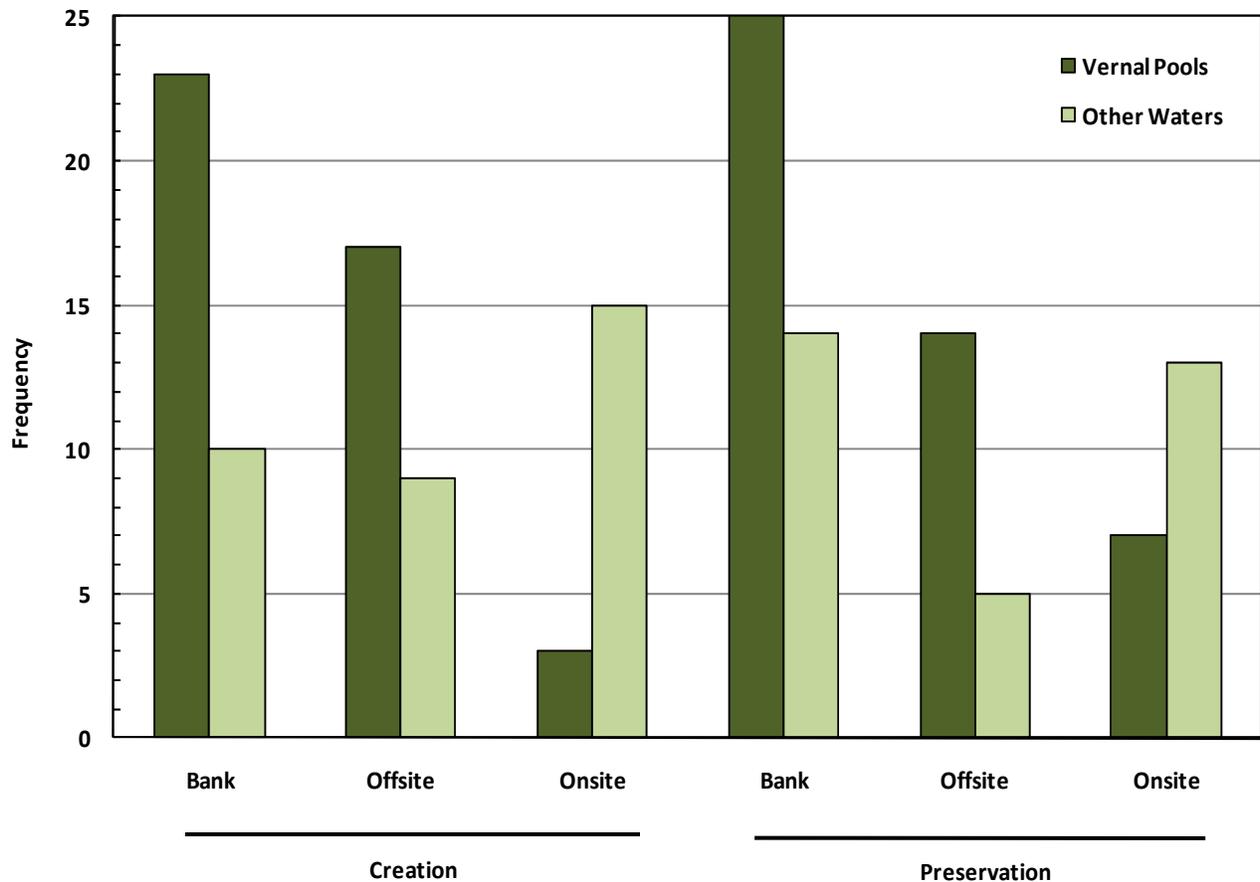
Acreage of vernal pools and other wetlands directly and indirectly affected by Central Valley projects for which the U. S. Army Corps of Engineers issued individual permits between 2000 and 2006

Figure 2

VERNAL POOL MITIGATION

The methods employed to mitigate for vernal pool and other wetland loss was analyzed to better understand how permitted losses were compensated. Unfortunately, data on mitigation methods were lacking for many of the permits. The number of permits found for each method is listed below.

Most projects fulfilled their mitigation requirements at off-site mitigation areas and mitigation banks, particularly vernal pool mitigation requirements (Figure 3). Of the 43 projects for which the vernal pool creation method could be determined, 40 (93%) used either a bank or an off-site mitigation area. Similarly, for the 46 projects with known vernal pool preservation methods, project proponents for 39 of the projects (85%) fulfilled at least a portion of their requirements at an off-site location or a bank. These patterns were similar for other wetland types, although other wetland types were much more likely to be mitigated on-site, with project proponents for 15 of the projects (44%) choosing to fulfill their creation requirements (n = 34) and project proponents for 13 of the projects (41%) choosing to fulfill their preservation requirements (n = 32) on the project site.

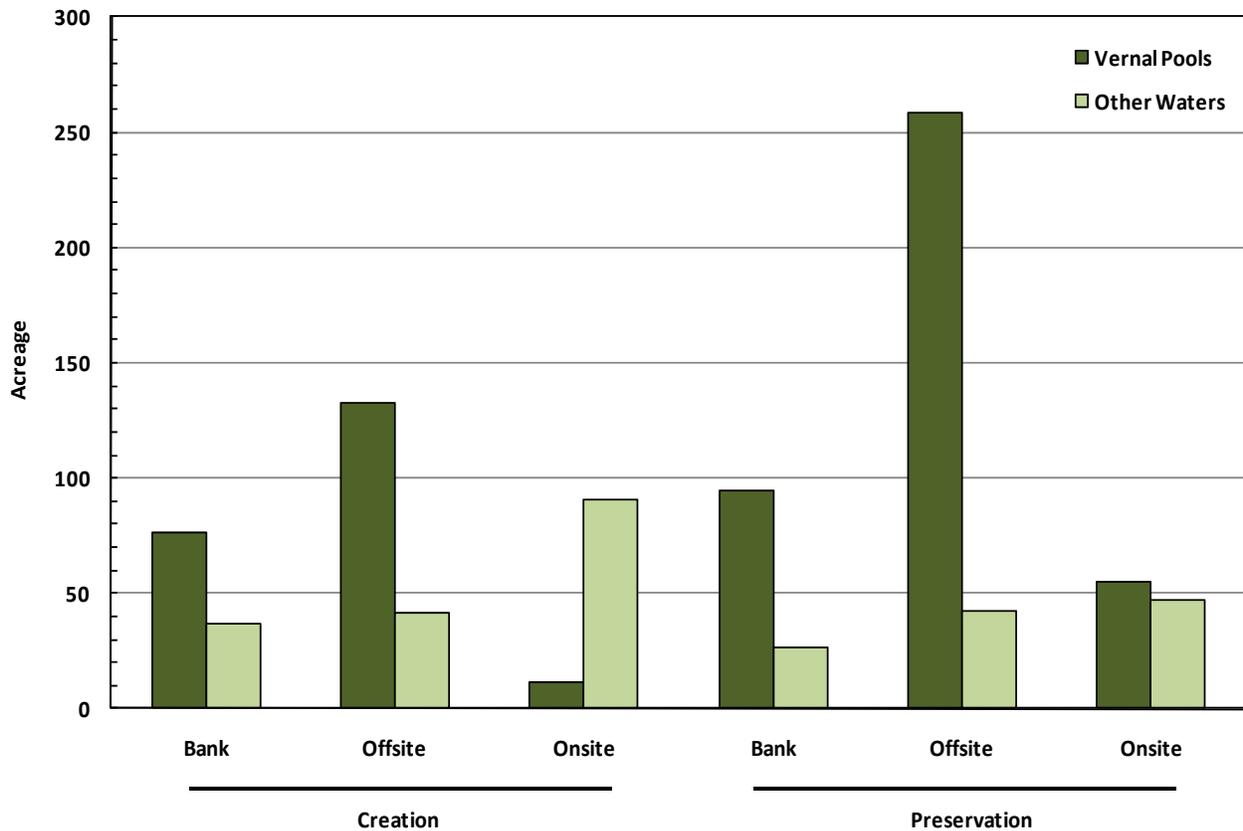


Source: Data provided by AECOM in 2009

Number of Central Valley projects that obtained an individual permit from the U.S. Army Corps of Engineers between 2000 and 2006 for fill of vernal pools that selected as mitigation method either a mitigation bank, offsite mitigation, or onsite mitigation

Figure 3

This general trend was similar for wetland mitigation acreage (Figure 4). Most created (or restored) and preserved vernal pool wetland acreage was located in either banks (35% of created and 23% of preserved acreage) or other off-site mitigation areas (60% of created and 63% of preserved acreage). The difference in acreage between, mitigation bank, off-site and on-site mitigation was statistically significant for both creation and preservation of vernal pool habitat (2-factor analysis of variance on log-transformed data: F-statistic = 7.84, degrees of freedom = 2 and 210, $P = 0.0005$), but did not differ between creation and preservation ($P = 0.7$). There was also no statistically significant interaction between the two factors (mitigation banks vs. off-site vs. on-site, compared to creation vs. preservation), that is the differences between mitigation bank vs. off-site vs. on-site mitigation acreage was the same for creation and mitigation ($P = 0.5$).



Source: Data provided by AECOM in 2009

Mitigation acreage allocated to either a mitigation bank, offsite- or onsite mitigation for Central Valley projects that obtained an individual permit from the U.S. Army Corps of Engineers between 2000 and 2006 for fill of vernal pools

Figure 4

For other wetlands, the opposite trend was observed, with most of the created (or restored) and preserved mitigation wetland acreage located in on-site areas. Because our analysis focused solely on individual permits, none of the projects used the USFWS or USACE in-lieu fee programs to mitigate for vernal pool wetland loss. Again, the differences in acreage between mitigation bank, on-site and off-site mitigation were statistically significant (2-factor analysis of variance on log-transformed data: F-statistic = 7.48, degrees of freedom = 2 and 210, P = 0.001), and there was no statistically significant difference between creation and preservation (P = 0.2) and no significant interaction (0.9). Examining the ratio between the acreage of wetlands lost and acreage of wetlands created or restored and preserved as mitigation, slightly different patterns were observed. For vernal pools, approximately 1.2 acres of wetlands were created or restored for each acre of vernal pool that was lost and 2.2 acres were preserved. For other wetlands, the creation or restoration ratio was slightly higher (1.5:1) while the preservation ratio was substantially smaller (1:1).

Geographic Information Systems software was used to describe general trends in project site and corresponding mitigation site vernal pool grassland acreage among Central Valley counties; however, information detailing how mitigation requirements were met was lacking for many projects. Twenty-six of the projects where the vernal pool creation or preservation method was known (43 and 46 projects, respectively) contained information describing how vernal pool mitigation requirements were met (i.e., the name of the mitigation site or bank where mitigation habitats were created or preserved), and 32 different mitigation locations were recorded for these 26 projects. Of the 32 different mitigation areas that were identified and that could be linked to a specific USACE mitigation

requirement, 31 could be mapped in ArcGIS. The results presented below are based on these 26 projects and 31 mitigation areas.

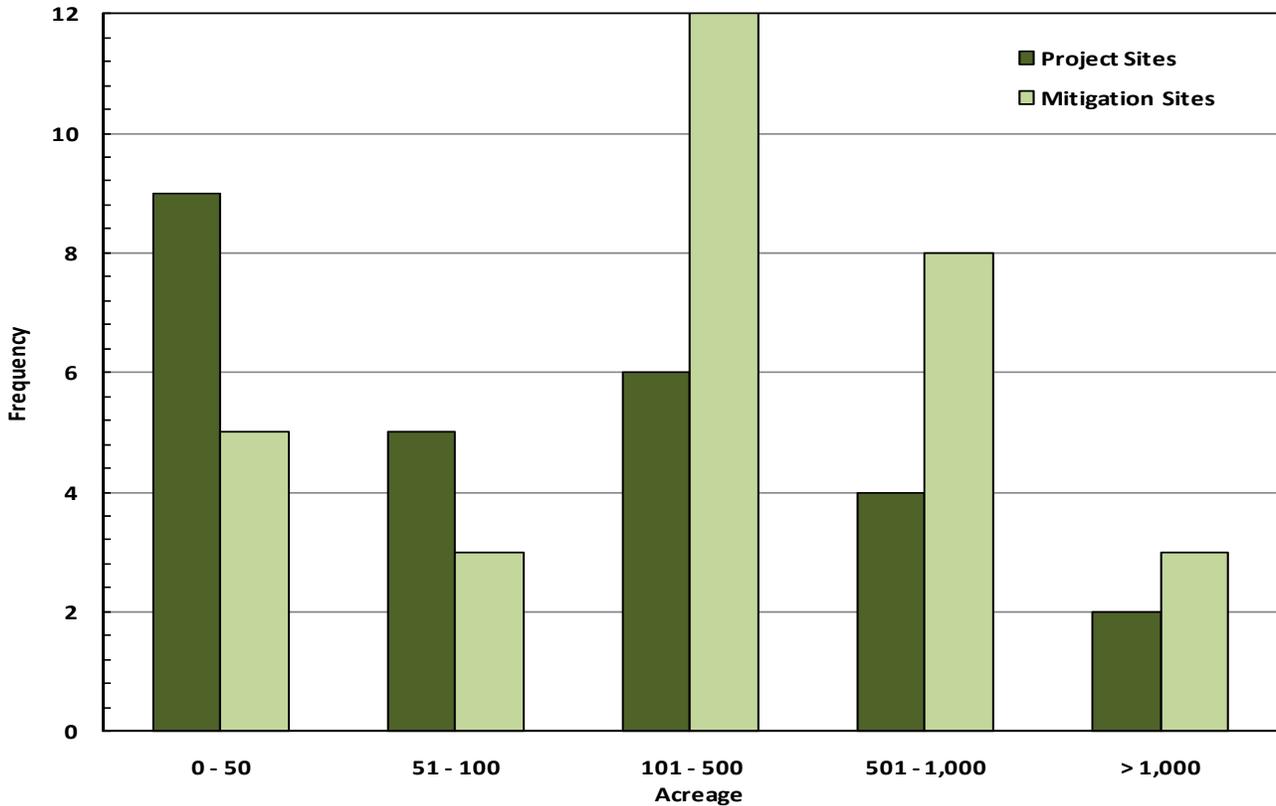
Table 7
Project site and mitigation site areas by county for Central Valley projects that received individual USACE permits for placing fill in vernal pools between 2000 and 2006

County	Project Sites			Mitigation Sites		
	Number of Projects	Acres	Average Size (acres)	Number of Projects	Acres	Average Size (acres)
Placer	10	5,682	568	14	4,835	345
Sacramento	9	1,383	154	7	4,015	574
Shasta	3	1,175	391	5	1,239	248
Fresno	1	938	939	0	0	0
Solano	2	628	314	3	1,580	527
Butte	1	65	65	1	2,410	2,410
Madera	0	0	0	1	923	923
Total or average	26	9,871	380	31	15,001	484

Source: Data provided by AECOM in 2009

Considering the entire study area, both the total acreage of vernal pool grassland and the average acreage of habitat per site were higher for mitigation sites when compared to corresponding project sites (Table 7). However, different trends were observed in individual counties. For example, contrasting trends were observed in Sacramento and Placer Counties, the two counties with the most projects and mitigation sites in the study (Table 7). Placer County saw a net loss in vernal pool grassland, at least for the projects affecting vernal pools that were tracked in the database, with a total decline of approximately 850 acres of habitat. The preserves in Placer County were also much smaller, on average about 220 acres, than the corresponding project sites. An opposite pattern was seen in Sacramento County, where mitigation site vernal pool grassland acreage exceeded project site acreage by more than 300%, and the average size of a mitigation site exceeded the average size of a typical project site by more than 350%. Examining the distribution of project and mitigation site acreages, it is apparent that there is a clear difference in the sizes of most project sites when compared to mitigation sites. Although there were a similar range of sizes for the project sites and mitigation sites examined in this study (project sites ranged from 15 to 2,463 acres in size and mitigation sites ranged from 6 acres to 2,410 acres), the distribution of project sites is clearly skewed toward smaller acreages and the distribution of mitigation sites is clearly skewed toward larger acreages (Figure 5).

GIS was used to examine differences in the distribution of vernal pool landforms between project sites and mitigation sites (Figure 6). There was little change in the relative amount of acreage found across the four main types of vernal pool landforms. A slight shift was apparent in the two most common vernal pool landforms, with low terrace landforms less frequently represented, in terms of relative acreage, on mitigation sites, and high-terrace landforms more frequently represented in mitigation sites. Volcanic mudflow and lavaflow landforms were also represented with lower acreage at mitigation sites than at project sites.

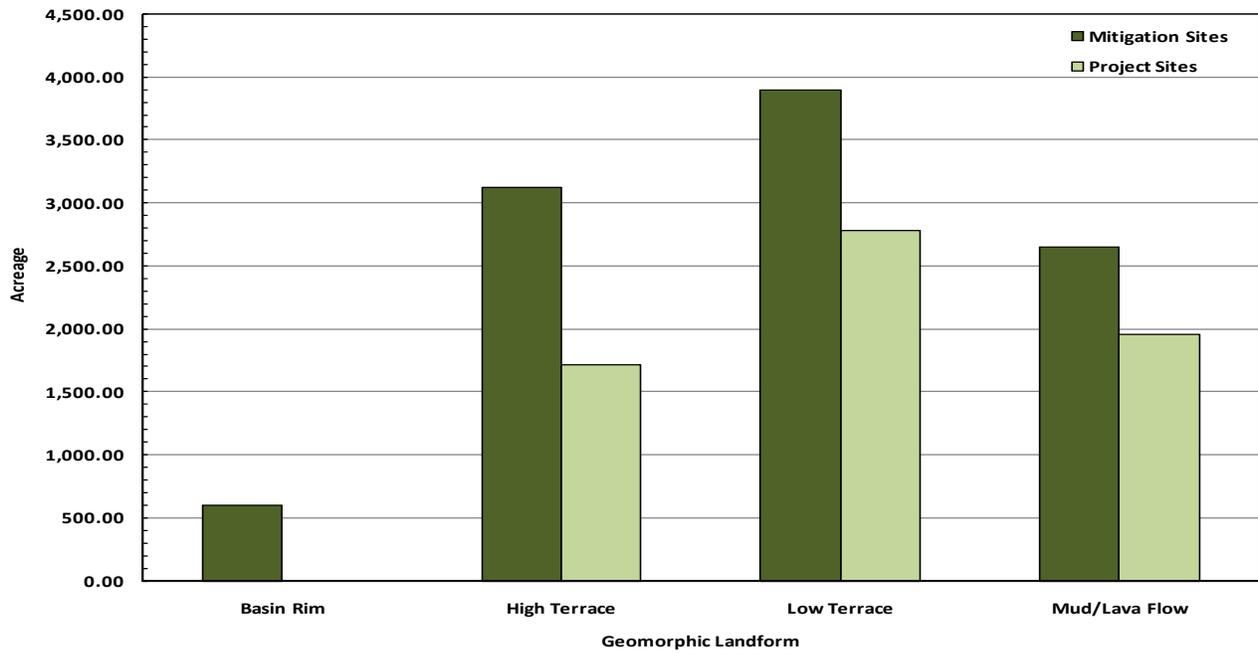


Source: Data provided by AECOM in 2009

Frequency distribution of project site and mitigation site acreages for Central Valley projects that obtained an individual permit from the U.S. Army Corps of Engineers between 2000 and 2006 for fill of vernal pools

Figure 5

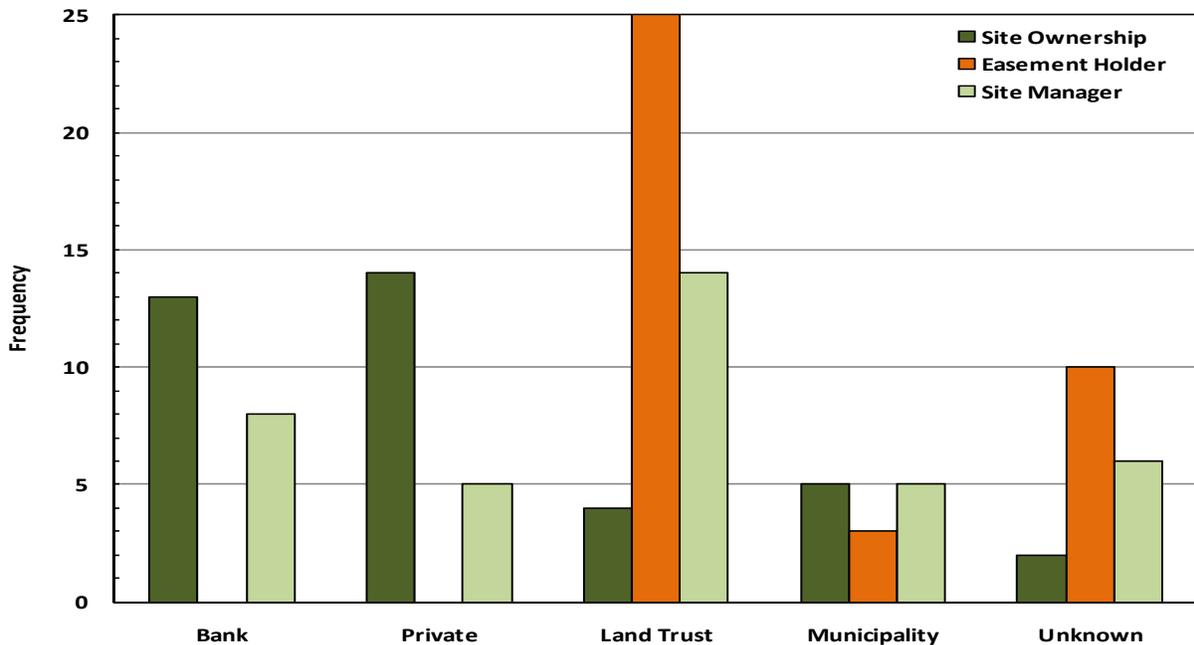
Finally, data detailing ongoing management practices of mitigation areas (e.g., annual monitoring reports) were almost entirely lacking in the permit files, despite the fact that such reports are often required by the USACE as a condition of approval for most mitigation sites. However, it was possible to describe the types of organizations that are owners, easement holders, and/or managers for the 32 vernal pool mitigation sites that were related to the 26 projects where the mitigation location was documented in the USACE permit file (Figure 7). Private for-profit entities (including mitigation and conservation banking firms) are the primary owners of most mitigation sites, whereas government organizations and nonprofit land trusts usually hold the conservation easement over most mitigation areas. Long-term management responsibilities for vernal pool mitigation sites are evenly divided between land trusts and for-profit entities (typically, mitigation banking firms and environmental consulting firms), with government agencies infrequently filling this role.



Source: Data provided by AECOM in 2009

Frequency distribution of project and mitigation sites acreages by landform for Central Valley projects that obtained an individual permit from the U.S. Army Corps of Engineers between 2000 and 2006 for fill of vernal pools

Figure 6



Source: Data provided by AECOM in 2009

Frequency distribution of owners, managers, and conservation easement holders across different types of organizations for vernal pool preserves established for Central Valley projects that obtained an individual permit from the U.S. Army Corps of Engineers between 2000 and 2006 for fill of vernal pools

Figure 7

DISCUSSION

Analysis of vernal pool cumulative impacts and associated mitigation was hampered by a lack of necessary data in USACE permit files. Throughout the process, important information, particularly information relating to mitigation measures, was either entirely missing from the permit file or lacking in detail and specificity. For example, of the 64 individual permit files that were received through the FOIA process and that permitted the fill of vernal pools, seven did not specify the size of the project site, total project site wetland acreage and the amount of wetland impacts permitted by USACE was unknown for 11 of the permits, 21 of the permit files did not specify the required acreage of vernal pools to be created or restored as mitigation, and 18 did not specify the vernal pool acreage to be preserved as mitigation. Despite these challenges, the following comments concerning the vernal pool permitting and mitigation processes are offered.

1. Almost all permit files contained the USACE permit and a copy of the USFWS BO. Other important documents that would have been useful to more fully characterize the biological effects of the proposed projects were less commonly found, particularly in older permit files. Documents commonly missing include the wetland delineation, biological assessment, mitigation and monitoring proposal, and mitigation site long-term management plan. Because this information was frequently lacking from the older permit files, as well as from some of the more recent permit files, it was difficult to determine the biological values of the habitats that were affected by permitted activities and how mitigation requirements were met.
2. Based on the files that were reviewed, approximately 16,900 acres of vernal pools and surrounding grasslands were potentially affected by USACE-permitted activities between 2000 and 2006. Included within the 16,900 acres were 310 acres of vernal pool wetlands and 270 acres of other wetlands and waters. Effects on 184 acres of vernal pools were permitted by USACE during this period, most of which were direct effects resulting in the fill of vernal pools. Indirect effects may have included effects on wetlands on adjacent project sites (i.e., projects not included in the 16,900 acres of project sites mentioned above), but there is no way to determine the acreage of indirectly affected wetlands on study project sites versus adjacent sites.
3. Most project proponents assumed that species federally listed as threatened and/or endangered were present on the project site. This is particularly true for listed vernal pool branchiopods. The presumption of presence can preclude the discovery of new populations of vernal pool-dependent species, many of which have disjunct distributions throughout the Central Valley (e.g., Conservancy fairy shrimp).
4. Mitigation acreage requirements, where they are found in USACE files, appear to be adequately replacing affected vernal pool acreage. Based on the files that were reviewed, approximately 1 acre of vernal pool wetland was created and 2 acres preserved for every acre affected. However, when total vernal pool grassland acreage (i.e., vernal pools and the surrounding grassland habitat) is considered, it appears that some localized areas of net habitat loss exist, particularly in Placer County. The loss of surrounding grassland habitat may have conservation implications for locally unique vernal pool plant communities and taxa particularly dependent on grasslands (e.g., California tiger salamander, western spadefoot, raptors or grassland-obligate songbirds).
5. Mitigation ratios for vernal pools largely followed the typical mitigation ratios specified in the programmatic BO between the USACE and USFWS (BO # 1-1-96-F-1) for projects with relatively small effects on federally-listed vernal pool crustaceans (i.e., projects typically resulting in 0.5 acre of vernal pool loss or less), despite the fact that all projects analyzed in this study resulted in more than 0.5 acre of vernal pool loss.
6. On average, most vernal pool preserves are larger than their corresponding project sites. Again, Placer County is the exception, with the average preserve being roughly 220 acres smaller than the average project site. As a general ecological principle, larger areas of habitat are usually less prone to edge effects and stochastic events that could affect the health and persistence of native plant and animal populations.

7. A small shift in the type of vernal pool landscapes being preserved was apparent in the mitigation sites that were tracked through the USACE permit files. Low-terrace landforms, which occur closer to the valley floor, where development pressures are higher, are becoming less common in vernal pool preserves relative to project sites, whereas high-terrace landforms are becoming relatively more common. The conservation implications of this phenomenon are unclear but potentially significant for vernal pool species such as vernal pool tadpole shrimp that may more often be found in pools forming on low-terrace landforms (e.g., Platenkamp 1998) and should be investigated further.
8. Because of the lack of data, it was difficult to determine how mitigation requirements were met for many projects. Only a minority of the permit files where the mitigation requirements were specified listed the name of the proposed mitigation site and contained a restoration plan and/or long-term management plan, and the files rarely included information verifying that the mitigation had been implemented. Even fewer of the files (13 of 64) contained a follow up monitoring report or similar document that analyzed the success of the mitigation site or ongoing stewardship of the mitigation site.
9. Because most files did not contain copies of long-term management and monitoring reports, it is not possible to determine the status of most vernal pool mitigation sites by reviewing permit files. Given that mitigation areas will be critical to vernal pool conservation efforts, particularly in rapidly urbanizing portions of the Central Valley, and the dearth of data contained in permit files, additional research examining the ecological condition of vernal pool mitigation sites and a review of mitigation site funding and management practices seem warranted.
10. The amount of actual vernal pool habitat loss stated in this report may be overestimated because permitted projects may never be built due to changes in economic circumstances or other factors. As a cursory analysis, digitized project footprints were compared with extirpated vernal pool polygons as digitized by Holland (2009). Approximately 10 permitted projects in Sacramento County and 5 projects in Placer County had been digitized by Holland as extant habitat. These projects accounted for 35 acres and 4 acres of vernal pool wetland habitat, respectively. Although permits have been issued for these projects, it is possible that they may not have been developed, or that they were developed following 2005 when the source imagery used in the Holland analysis was created.

This study largely confirms the results of previous studies analyzing cumulative impacts on other wetland types through a review of USACE permit files (e.g., Holland and Kentula 1992, Kentula et al. 1992). In short, the files are frequently lacking the information that would be required to conclusively document the amount and type of wetland loss occurring in a given region and the measures that are being implemented (as well as the success of those measures) to mitigate for permitted wetland loss. The authors of this study, like authors of the previous studies, recommend better organization of data files, better tracking of documents throughout the permitting process, and more followup to verify that mitigation measures have been implemented and that those measures have been successful. Without these improvements, it is likely that USACE cannot adequately ensure that no net loss of vernal pool functions and values is occurring through the Section 404 permitting process.

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