An Evaluation of Compensatory Mitigation Projects Permitted Under Clean Water Act Section 401 by the California State Water Resources Control Board, 1991-2002.

Richard F. Ambrose[1]
John C. Callaway[2]
Steven F. Lee[1]

[1]University of California, Los Angeles
[2]University of San Francisco

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Final Report

Richard F. Ambrose[1,2]
John C. Callaway[3]
Steven F. Lee[2]

With technical assistance from:

UCLA: **Elizabeth Bernier, Leanna Heffner, Marjorie Lundgren, Lisa Max, Natalie (Wenner) Diaz**

[1]Environmental Science and Engineering Program
[2]Department of Environmental Health Sciences
University of California, Los Angeles
Los Angeles, CA 90095-1772

USF: **Robert Genova, Robert Goldstein, Sandee Hufana, Laura Wainer**

[3]Department of Environmental Science
University of San Francisco
2130 Fulton St.
San Francisco, CA 94117-1080

Prepared for:

State of California
California Environmental Protection Agency
California State Water Resources Control Board
Los Angeles Region (Region 4)
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Los Angeles, CA 90013
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Abstract

The purpose of this project, which was funded by the California State Water Resources Control Board (SWRCB), was to evaluate the compliance and wetland condition of compensatory wetland mitigation projects associated with Clean Water Act Section 401 Water Quality Certifications throughout California. This was done by selecting, reviewing and performing field evaluations for 143 permit files distributed across the 12 Water Board regions and sub-regions of the State. For each permit file we assessed the extent to which permittees complied with their mitigation conditions, including acreage requirements, whether the corresponding mitigation efforts resulted in optimal wetland condition, and if the habitat acreages gained through compensatory mitigation adequately replaced those lost through the permitted impacts. We found that permittees are largely following their permit conditions (although one-quarter to one-third of the time these are not met), but the resulting compensatory mitigation projects seldom result in wetlands with optimal condition.

Methods

Our goal was to evaluate the mitigation actions associated with at least 100 randomly chosen Section 401 permit files issued in California between 1991 and 2002. The permit files were selected using the SWRCB's permit tracking database, and reviewed through multiple visits to the SWRCB, each of the three Army Corps of Engineers district offices (Los Angeles, San Francisco, and Sacramento), and various Regional Boards. Ultimately, 143 permit files were assessed; mitigation projects from 129 permit files were visited for assessment of compliance with permit conditions (including acreage) and wetland condition, and 14 additional files were evaluated for compliance only.

Our determinations of Section 401 compliance included consideration of all mitigation conditions specifically outlined in the 401 permit letter, plus any additional conditions found in other agency permits when the 401 permit included explicit or implicit statements requiring that those documents be followed. In addition to the regulatory permits, the mitigation plan, if present, was carefully read to extract the essential compliance elements. Compliance with these conditions was scored using categorical scores, on a scale from 0% (no attempt to comply) to 100% (condition fully met).

To evaluate existing wetland condition, we performed the California Rapid Assessment Method (CRAM) at all assessable mitigation sites associated with our permit files. CRAM includes evaluations of the following attributes: buffer and landscape context, hydrology, physical structure and biotic structure. To provide a sound foundation for evaluating mitigation sites in this study, we established categories of wetland condition (optimal, sub-optimal, marginal and poor) based on the results from CRAM evaluations performed at 47 reference sites distributed throughout the state.

At each mitigation site we also mapped the border of the mitigation sites using GPS to evaluate acreages and determined the approximate proportions of jurisdictional

and non-jurisdictional habitat types that were present. These proportions, along with the overall site acreages, were used to calculate the component acreages of “waters of the U.S.” versus non-“waters” habitats, wetlands versus non-wetland “waters,” and subsets of these habitat types. These were compared to the impact acreage values in the permits to evaluate “no net loss” from the standpoint of habitat acreages.

Results

Of the 143 permit files assessed in this study, 129 had compensatory mitigation sites that could be assessed in the field (the mitigation requirements for the other 14 permit files could be assessed for compliance, such as fee payments to preservation or conservation banks, but there were no compensatory mitigation projects to assess). The mitigation sites were well distributed across the state, although some regions had issued relatively few 401 permits and, thus, had correspondingly few site evaluations (Figure AB-1). Many of these 129 permit files had multiple mitigation actions (e.g., wetland creation plus riparian enhancement) that needed to be evaluated separately; a total of 204 discrete mitigation sites were surveyed and evaluated. Of these 204 mitigation projects, 62% were onsite (i.e., within the greater boundaries of the permitted project area) and the rest were offsite. Seventy-five percent of these 204 sites involved permittee-responsible mitigation linked to specific permits files, while 25% involved third-party strategies (mitigation banks or in-lieu fee payments) or were part of larger mitigation projects used by permittees for multiple permits.

We looked at compliance in two ways. First, we assessed the degree of compliance with each condition, with the potential scores for each of these conditions ranging from 0 to 100%, and then we took the average of these compliance scores across all conditions; this is called the “average compliance score.” For the 124 files with assessable 401 conditions, the average compliance score for 401 conditions was 84%. Second, we assessed compliance as the percentage of permit conditions that were met completely (100% score) for a particular file (hereafter, percent-met score). The average percent-met score was 73% (Table AB-1). Forty-six percent of the files fully complied with *all* permit conditions. The average compliance score based on mitigation plan requirements (a proxy for all agency requirements) was slightly lower than the 401 compliance scores (81% vs. 84%). Only 16% of the files fully complied with all mitigation plan conditions; however, 42% had scores of 90% or greater. Compliance with 401 permit conditions showed no trend over time, and there was no significant difference in 401 compliance or mitigation plan compliance among regions. We found high compliance for third-party mitigation requirements (mean score 99%) and relatively low compliance for monitoring and submission requirements (mean score 59%). The mean scores for other compliance categories ranged from 76-85% (Table AB-2). In general, most 401 permits contained relatively few compensatory mitigation-related permit conditions (often a single acreage-related requirement was specified); conditions regarding success and performance standards were notably infrequent, although these were more commonly included in other permits or the mitigation plan.

CRAM evaluations were conducted at each of the 204 discrete mitigation sites. Fifty three of these mitigation sites were sub-sampled because they were too large or complex for a single CRAM evaluation. Thus, a total of 321 separate CRAM evaluations were completed for this study.

Despite relatively high permit compliance, most mitigation sites were not optimally functioning wetlands based on the criteria we established from reference wetlands across the state. Mitigation sites had an overall mean score of only 59% (Figure AB-2). On average, sites scored better for biotic structure (e.g., plant community metrics) than for the hydrology attribute (Figure AB-3). Only 19% of the mitigation files were classified as optimal, with just over half sub-optimal and approximately one-quarter marginal to poor. There was some variation in CRAM scores among the SWRCB regions, with Region 2 exhibiting a slightly lower mean CRAM score than other regions (Figure AB-4). We did not assess function at impacted sites, nor did we assess function at the mitigation sites before the mitigation action was taken; therefore, it was not possible to compare directly the functions lost through permitted activities to those created through compensatory mitigation.

The 143 Section 401 permits that were evaluated authorized approximately 217 acres of impacts (including temporary impacts) and required that 445 acres of mitigation be provided. Our analyses indicate that 417 acres of actual mitigation acreage was obtained; 72% of files met or exceeded their acreage requirements, resulting in an overall mitigation ratio of 1.9**:**1. When considering permanent impacts (true losses) to creation and restoration mitigation (true gains), our results showed that "no net loss" *of acreage* is being achieved (1) overall, (2) for jurisdictional "waters of the U.S." acreage, and (3) for wetlands themselves (Table AB-3). However, 39% of individual files resulted in net acreage losses overall, 47% resulted in a net loss of jurisdictional "waters" acreage, and 28% had net wetland losses (Table AB-4).

A simple reporting of overall acreage losses and gains does not provide the full picture of "no net loss" of wetland acreage (much less wetland function, discussed below). A simple accounting assumes no existing wetland acreage was present at the mitigation site prior to any mitigation activity (not always the case) and it does not address whether the habitat types mitigated were appropriate given the corresponding impacts. Within most regions, the habitat types mitigated were appropriate given the impacts (Figure AB-5); however, approximately 50% of the mitigation acreage within Regions 4 and 5S consisted of drier riparian and upland habitats that were outside jurisdictional "waters of the U.S." Overall, 27% of mitigation acreage was non-jurisdictional. Vague regulatory language and a lack of clear accounting have contributed to this result; in the reporting of regulated impacts, the term "riparian" refers only to habitats within "waters of the U.S." while in mitigation planning, a broader definition of riparian has often been applied that includes the entire zone of transition to fully terrestrial habitats, including non-jurisdictional habitat.

In comparing results from permit compliance, acreage requirements and wetland condition, we found little relationship between these different aspects of mitigation. For example, meeting acreage requirements was not related to overall permit compliance (r^2=0.002), nor was there any relationship between percent acreage met and CRAM score for wetland condition (r^2=0.015). General compliance with permit conditions was statistically correlated with CRAM scores; however, low r^2 values indicate the relationships between the variables were not very strong (mean 401 compliance score and CRAM score, r^2=0.126 (Figure AB-6); mean percent of 401 conditions met and CRAM score, r^2=0.207; and mitigation plan compliance and CRAM score, r^2=0.150).

Taken together, the findings of this study suggest that permittees are, for the most part, meeting their mitigation obligations, but the ecological condition of the resulting mitigation projects is not optimal (Figure AB-7). Given the low ecological condition of most mitigation wetlands, it seems likely that many mitigation projects did not replace the functions lost when wetlands were impacted, and hence that the goal of “no net loss” of wetland functions was not met, but this study cannot provide a definitive conclusion on this issue. To understand the net loss (or gain) in wetland function resulting from mitigation, functional assessments would be needed at the impact site before and after the impact occurred to determine the loss of functions, and at the mitigation site before and after the mitigation project was completed to determine the gain in functions. Linking gains to losses is difficult in a retrospective study such as this, and we have not attempted to do so. However, the low CRAM scores for most mitigation projects indicates that many of these projects are not functioning well as wetlands, and in the context of the likely condition of the original wetlands before they were impacted, it seems probable that a net loss of wetland function did occur for the wetlands included in this study.

The functional deficiencies of the mitigation projects and the likely failure of many projects to compensate for the loss of wetland functions are largely due to shortcomings in mitigation planning and in the development of the permit conditions. The root of these shortcomings lies with a lack of explicit consideration of the full suite of functions, values, and services that will be lost through proposed impacts and might be gained through proposed mitigation sites and activities. In short, this is at least partly due to regulatory agencies approving mitigation projects with conditions or criteria that are too heavily focused on the vegetation component of wetland function, with inadequate emphasis on hydrological and biogeochemical conditions and their associated functions and services (e.g., flood attenuation, water quality improvement).

Recommendations

The results of this study have informed a large number of recommendations (Table AB-5). The recommendations are separated into five main categories.

First, we present recommendations aimed at improving mitigation requirements. These recommendations mainly concern permit conditions, but also issues of the location of mitigation projects and how gains and losses associated with a project are tracked by habitat. The success of compensatory mitigation depends fundamentally on the mitigation requirements specified by the regulatory agencies. Our study found relatively high levels of compliance with mitigation permit conditions. In addition, there was no relationship between compliance with permit conditions and the condition of wetland mitigation sites. It appears that compliance with permit conditions yields no guarantee that a mitigation wetland will have high condition or function. Perhaps the most effective way to improve the success of compensatory mitigation would be to include permit conditions that lead to better mitigation projects.

Second, we present recommendations under the general heading of information management. Retrieving specific permit files was problematic during this study. Of the 429 files we sought, we could locate only 257 despite extensive efforts to do so. The difficulty in locating files had a variety of causes, ranging from limitations in the database to the physical management of hardcopy permit files. These recommendations concern improvements to the database (either the existing database, or a modified database), improvements to permit archiving, and improvements to tracking the progress of mitigation projects.

Third, we present recommendations to improve the clarity of permits. Permit conditions should be written as clearly assessable criteria, with individual conditions for each specific criterion to be evaluated. Permit conditions should be written with a clear and direct method of assessment in mind. Our results suggest that more clearly written conditions would improve the chance of compliance. Presently, some conditions are too vague or may be presented in a way that it is not possible to assess them.

Fourth, we recommend that the goal of "no net loss" be assessed in a more effective manner. Although we were able to assess whether there has been a net loss of wetland acreage, studies of the functions of wetlands before and after construction at both impact and mitigation sites are required to evaluate the net change in wetland functions.

Finally, we present recommendations concerning coordination with other agencies. Although the State Water Resources Control Board has responsibility for 401 permits, the entire process of regulating impacts to wetlands and "waters of the United States" is closely coordinated with other agencies, especially the U.S. Army Corps of Engineers and the California Department of Fish and Game. Improved information management might improve this coordination.

Compliance Monitoring

The results of this study clearly indicate the need to evaluate the compliance of mitigation projects with their permits. Thirteen of the 257 permits we located had to be excluded because of potential compliance issues. This indicates that up to 5% of the files we reviewed may have significant compliance problems (such as the impact occurring but no mitigation being undertaken). Our analysis of discrepancies between 401 permits and information in the permit files identified additional compliance issues. For example, 8% of the 143 files we evaluated had information indicating that the actual impacts were greater than authorized in the 401 permit; overall, there appeared to be compliance issues with **42%** of the files we evaluated. Compliance varied across condition categories with relatively high scores for third-party mitigation requirements and relatively low scores for monitoring and submission requirements. Moreover, many of the categories we assessed had a high fraction of permits for which the conditions could not be assessed; for example, we could not assess monitoring and submission conditions for more than half of the permits.

These results indicate a definite need for compliance monitoring. Without a significant compliance effort, permittees are failing to comply with a wide range of permit conditions without the Water Board staff knowing about it.

Our data allow us to identify some areas that seem most likely to have low compliance. However, in our view it does not provide a very sharp focus. Compliance issues are spread quite broadly across all aspects of the 401 program, so compliance monitoring will also need to be spread quite broadly. The areas identified as having lower compliance might warrant a particular emphasis during compliance monitoring, but compliance was not so high for most other areas (with the possible exception of third-party mitigation conditions) that it would be safe to assume high compliance with them.

Although monitoring requirements were regularly included as 401 permit conditions, and evaluated for compliance when appropriate, the relative scarcity of monitoring reports in the permit files we reviewed suggest that compliance with the monitoring requirement is checked infrequently (although some monitoring reports may have been submitted by permittees but not placed in permit files). Our compliance assessment indicated that conditions requiring mitigation monitoring were met only about 53% of the time; it was unclear whether any enforcement actions were undertaken in response to the absence of monitoring reports. While we were conducting a similar study for the Los Angeles Regional Water Quality Control Board (Ambrose and Lee 2004), that region was compiling lists of permit files without monitoring reports and contacting permittees to obtain the reports. This seems like a relatively cost-effective area on which to focus compliance monitoring efforts.

We make two specific recommendations concerning compliance monitoring. First, we recommend that mitigation monitoring reports should be streamlined and focused around demonstrating compliance with an established list of permit conditions. Second, we recommend that regulatory agencies establish a multi-agency cooperative to monitor compliance and track wetland losses and mitigation success across the State.

Table AB-1. Summary of compliance scores based on 401 and mitigation plan evaluations including average scores and scores for the percentage of conditions met to 100% satisfaction. The average compliance score was calculated by assessing the degree of compliance with each condition, with the potential scores for each condition ranging from 0 to 100%, and then averaging these compliance scores across all conditions. Successful included files with compliance scores greater than 75%, partially successful included files with scores between 25% and 75%, and failure included files with scores less than 25%. The average percent-met score was calculated based on the percentage of permit conditions for a particular file that were met completely (100% score). Compliance was assessed for conditions included in the 401 permit and for all conditions included in the corresponding mitigation plan.

	N	Score	Successful	Partially Successful	Failure
Average 401 compliance score	124	84.3%	76%	20%	4%
Average 401 percent-met score		73.3%	57%	30%	13%
Average mitigation plan compliance score	81	80.7%	68%	32%	0%
Average mitigation plan percent-met score		67.6%	48%	35%	6%

Table AB-2. Section 401 compliance for different compliance condition category (N=143 files). All conditions were grouped into general categories to look for patterns in compliance with different types of permit conditions. Condition scores that could not be determined were labeled ND (Not Determinable). N/A indicates not applicable.

Condition Code	Condition Category	401			
		Total # Conditions	Average # Conditions	Average # ND	Average Score
1	Third Party	58	1.5	0.1	99.3
2	Acreage	158	1.8	0.2	81.5
3	Site Implementation	411	6.0	2.7	84.8
4	Site Maintenance	49	1.6	0.8	76.0
5	Site Protection	66	1.5	0.6	81.3
6	Success & Performance Standards	199	3.9	1.5	76.4
7	Monitoring & Submission	254	3.6	2.0	59.5
8	Invocation of Other Agency Permits	126	1.7	1.1	N/A
9	Other	35	1.3	0.6	96.1
3 - 6	Site Implementation, Maintenance, Protection, Success/Performance Standards	725	3.2	1.4	79.6

Table AB-3. Permanent impacts and created mitigation acreage, including waters of U.S." and non "waters of U.S.," and wetland, non wetland "waters."

	Permanent Impact	Created Acreage	Proportion Obtained	Net Acreage Gain	Gained/Loss Ratio
Overall Acreage	165.8	270.9	NA	105.1	1.6
Waters of U.S.	162.7	223.1	82.4	60.4	1.4
Non Waters of U.S.	3	47.8	17.6	44.8	NA
Waters of U.S.:					
Wetlands	106.3	146.7	66.4	40.4	1.4
Non Wetland Waters	54.9	74.2	33.6	19.3	1.4

Table AB-4. Permanent impacts and created mitigation acreage, including "waters of U.S." and non "waters of U.S.," and wetland, non wetland "waters."

	% Files w/Gains	% Files Gained=Lost	% Files w/Loss
Overall Acreage	41	20	39
Waters of U.S.	36	17	47
Non Waters of U.S.	24	76	1
Waters of U.S.:			
Wetlands	40	32	28
Non Wetland Waters	17	37	46

Table AB-5. Summary of administrative and regulatory recommendations.

	Improving mitigation requirements	Information management	Improve permit clarity	Assessment of "no net loss"	Coordination with other agencies
Permit conditions should ensure complete compensation for the full suite of wetland functions and services lost	X				
Ensure that mitigation projects compensate for losses in water quality (pollution) improvement services	X				
There should be a better accounting of the habitat types lost and gained	X				
Mitigation projects should have appropriate landscape context	X				
Offsite mitigation should be within the same catchment, or at least the same watershed	X				
Improvements to Database		X			
Improve permit archiving		X			
Improve tracking the progress of mitigation projects		X			
Important permit information should be clearly delineated in tables			X		
Permit conditions should be written so that the extent of efforts must match the intent of the condition to be in compliance			X		
Every mitigation plan and permit should include a table of requirements upon which compliance will be judged			X		
Permits should be clear about the meaning of enhancement, restoration and creation			X		
Performance standards should be clear about the goal of invasive species control			X		
Proof of inundation or saturation appropriate for wetland development should be required for mitigation wetlands			X		
Pre- and post-construction functional assessments of impact and mitigation sites should be required				X	
Improve incorporation of final permit information into Water Board files					X
Consider developing an integrated permit					X

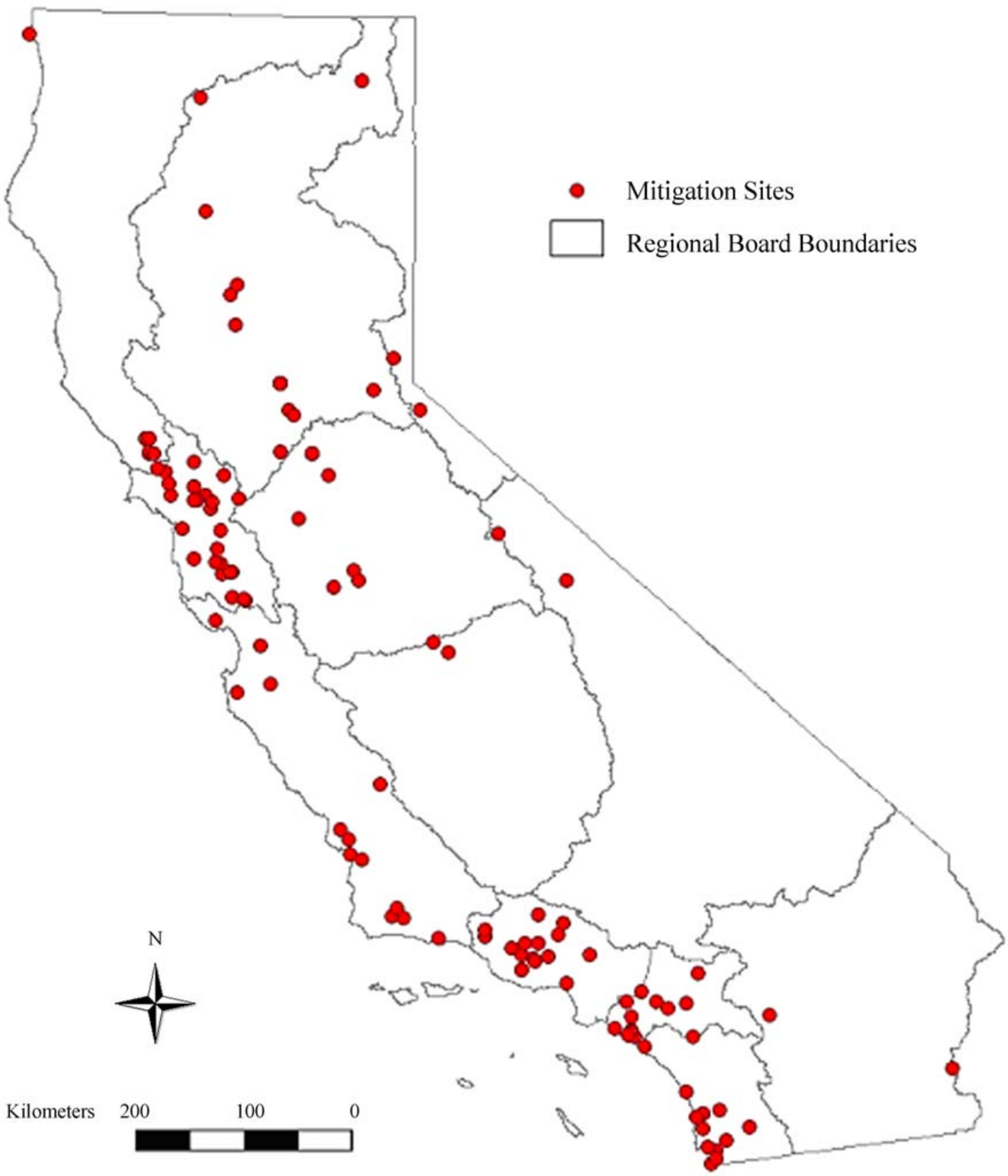

Figure AB-1. Statewide distribution of the assessed mitigation sites associated with the 143 permit files. Several of these sites, especially those in the central valley (Region 5) involved a collection of shared mitigation banks which resulted in fewer than 143 mitigation sites. Points represent each assessed mitigation site rather than multiple sites per file.

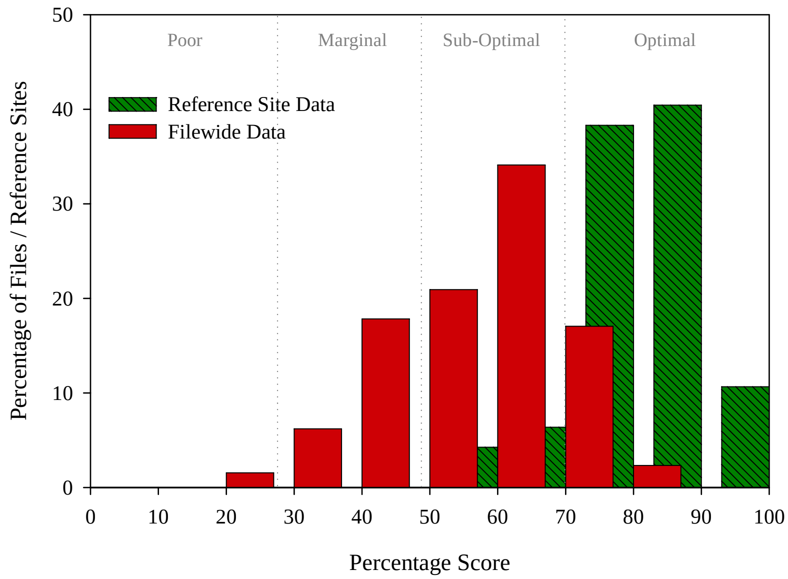

Figure AB-2. All CRAM data combined into a single overall wetland condition success score for each of the 129 files and 47 reference sites evaluated using CRAM.

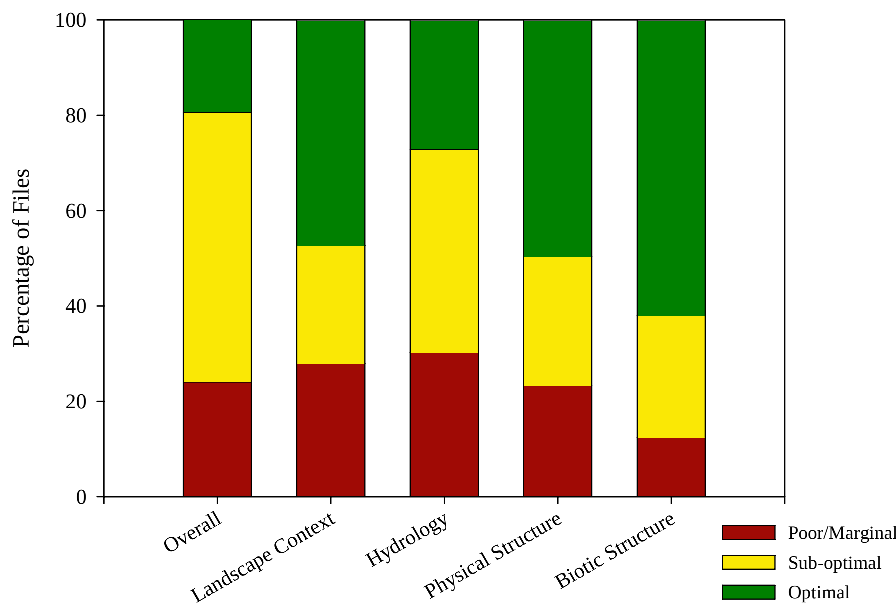

Figure AB-3. Percentage of files in CRAM success categories for overall CRAM scores and the four main attributes. For overall CRAM scores, optimal was considered 70 to 100 percent, sub-optimal was 49 to 70 percent (lower and upper bounds not inclusive), and marginal to poor was 49 percent and below. For buffer and landscape context, optimal was considered 74 to 100 percent, sub-optimal at 52 to 74 percent and marginal to poor 52 percent and below. For hydrology, optimal was considered 76 to 100 percent, sub-optimal at 53 to 76 percent and marginal to poor 53 percent and below. For physical structure, optimal was 53 to 100 percent, sub-optimal at 38 to 53 percent and marginal to poor 38 percent and below. For biotic structure, optimal was considered 47 to 100 percent, sub-optimal at 34 to 47 percent and marginal to poor 34 percent and below.

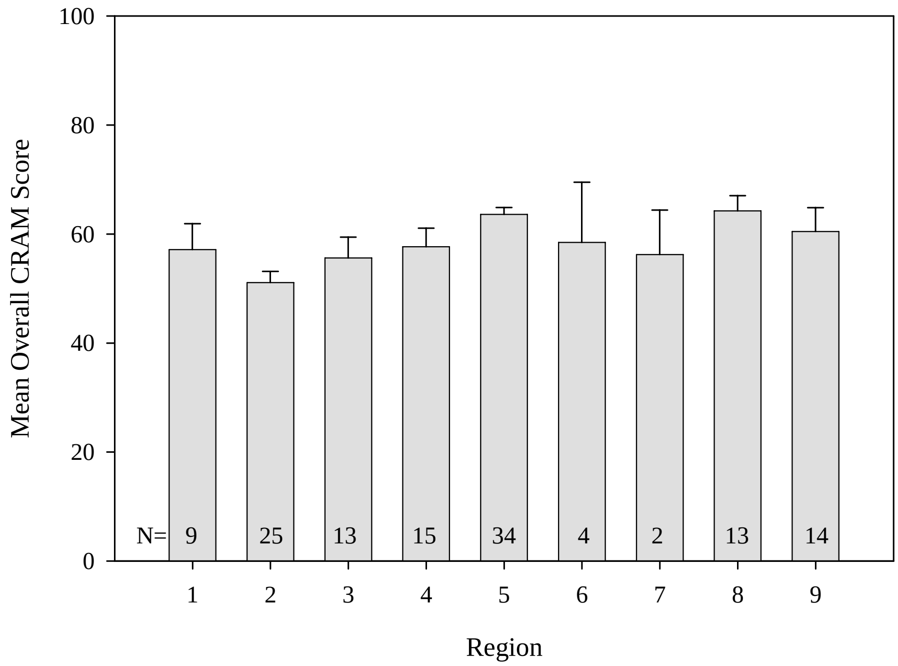

Figure AB-4. File-wide mean Total-CRAM percentage scores by State Board region (N=129 files).

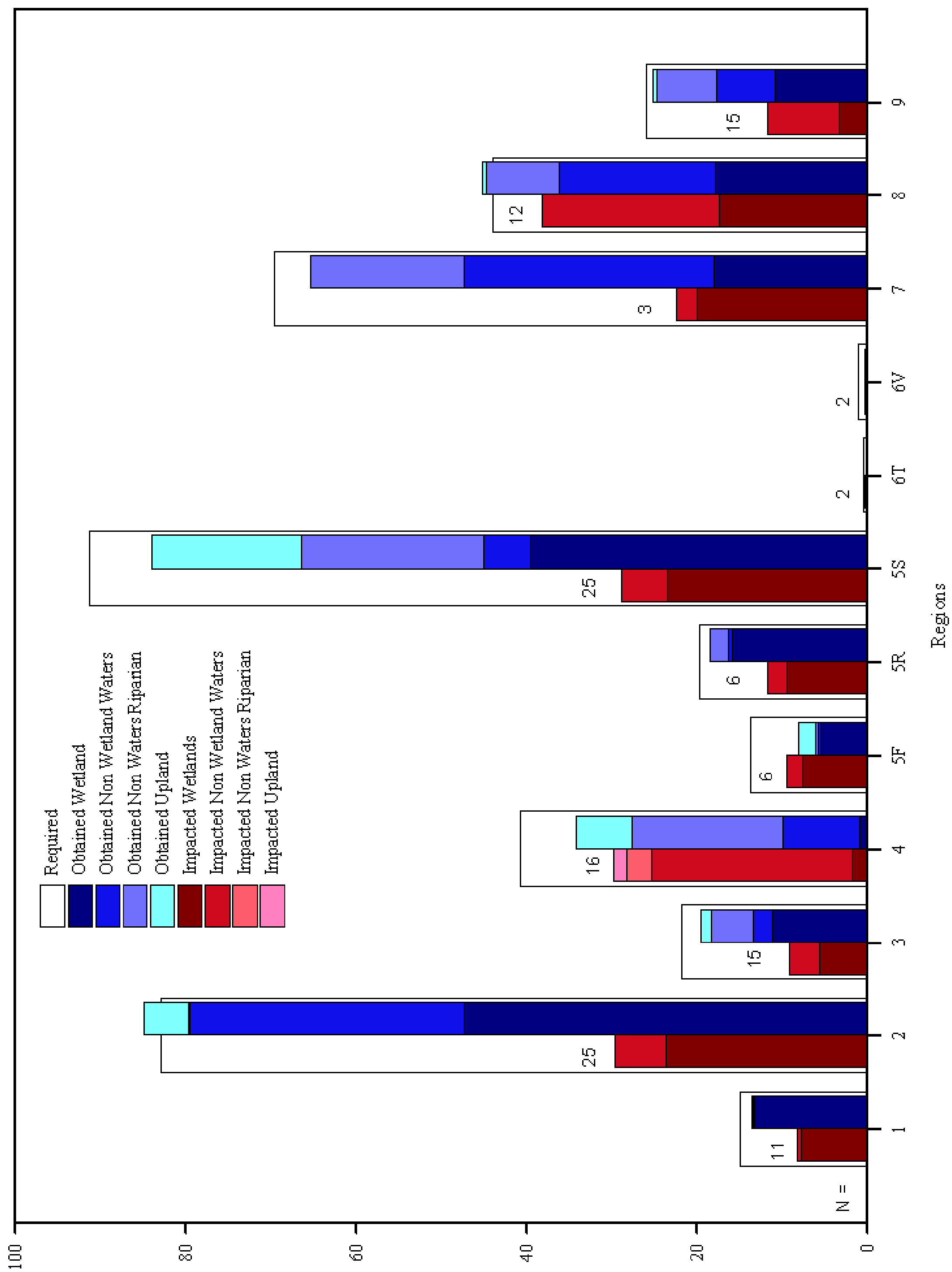

Figure AB-5. Total acreage impacted and obtained proportioned into jurisdictional wetland, and non-wetland "waters," or riparian and upland habitats by State Board region. Total required acreage per region is also displayed. N displayed = number of files assessed per region for both impacted and obtained. Total N=138 files (there were five files for which wetland acreage was not specified for "waters of the U.S.").

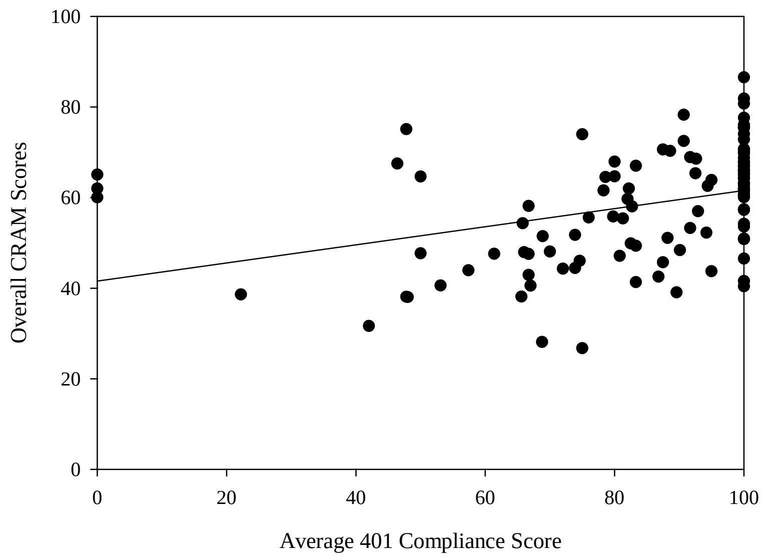

Figure AB-6. Correlation analysis between average 401 permit compliance score and overall file-wide CRAM score (N= 110 files; r^2=0.126, p=0.000).

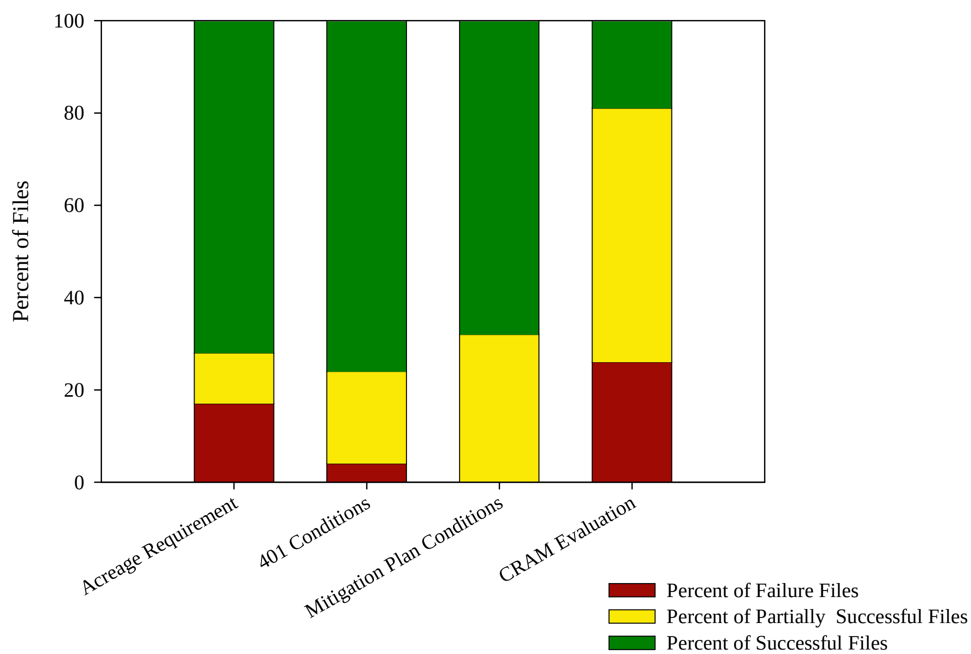

Figure AB-7. Mitigation success by permit file for each evaluation category: acreage requirement, 401 conditions, mitigation plan conditions, and wetland condition. Data shown for acreage and compliance are percentages out of a total number of 143 permit files. Wetland condition data are % out of 129 files. For the acreage requirements, success was considered 100%, partial success was considered 75- 100% (lower and upper bounds not inclusive), and failure was 75% and below. For the 401 and mitigation plan compliance evaluation, success was considered 75-100%, partial success was considered 25-75% (lower and upper bounds not inclusive), and failure was 25% and below. For the CRAM evaluation of wetland condition, success was considered 70-100%, partial success was 49-70% (lower and upper bounds not inclusive), and failure was 49% and below.

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1. Introduction

For about the last quarter century, the principle regulatory mechanism for the protection of wetland habitats has been Section 404 of the Clean Water Act (CWA). Every applicant for a 404 permit must also obtain state CWA Section 401 certification that the proposed discharge will not violate state water quality standards. In California the State Water Resources Control Board issues certifications for multi-Regional projects, and Regional Water Quality Control Boards issue certifications for projects entirely within their administrative regions. In addition, if the work will involve impacts to a streambed, a Streambed Alteration Agreement must be obtained from the State Department of Fish and Game (DFG), and if there are threatened or endangered species issues, the U.S. Fish and Wildlife Service and /or DFG may issue permits under the federal or State endangered species acts. Since about 1990, these regulatory agencies have pursued a State and National goal of "no net loss" of wetland acreage and function. Given this goal, any wetland losses that do occur must be offset through compensatory mitigation actions.[1] Within the regulatory framework, a strong emphasis has been placed on the avoidance and minimization of proposed impacts. However, the majority of CWA Section 404 proposals are ultimately approved (NRC 2001), making mitigation for permitted wetland impacts essential for the protection of wetland function.

1.1. Scope and Objectives

Recognizing the importance of compensatory mitigation in achieving "no net loss" and, more generally to assure compliance with regulatory mandates, the SWRCB contracted with the University of California, Los Angeles to conduct this study. The scope and objectives of the contract were:

> Beneficial uses of wetlands and riparian areas in California have been heavily impacted by a variety of projects, with more than 90% of California's wetlands and riparian areas lost. California's *Wetland Conservation Policy* establishes a "no net loss – long term gain" goal for wetland quantity, quality, and permanence (Executive Order W-59-93). The main tool used by the State Water Resources Control (State Board) and the Regional Water Quality Control Boards (Regional Boards) to protect wetlands and riparian areas is the Clean Water Act (CWA) §401 Water Quality Certification (WQC) Program. Section 401 WQC is associated with CWA §404 permits issued by the U.S. Army Corps of Engineers (USACE). A principal means to achieve the "no net loss" goal is the requirement for compensatory mitigation when unavoidable impacts to wetlands and riparian areas occur.
>
> Successful compensatory mitigation is technically complex, usually takes years to achieve, and can be expensive. Thus there is a real danger of failure, and a financial incentive for dischargers to avoid or minimize the necessary costs. These considerations argue for an effective compliance

[1] Compensatory mitigation is the creation, restoration, enhancement, or occasionally, preservation of wetland resources either onsite or offsite to offset permitted losses in wetland acreage and/or function.

mitigation program for compensatory mitigation projects. However, due to staffing constraints, the Regional Boards perform little or no such compliance monitoring. A second concern is that regulatory conditions, even if complied with, may not assure reestablishment of beneficial use quality or permanence. The National Academy of Sciences, in a 2001comprehensive review of wetland compensatory mitigation in the U.S. found that the national "no net loss" goal is not being met because (1) there is little monitoring of permit compliance, and (2) the permit conditions commonly used to establish mitigation success do not assure the establishment of wetland functions. The San Francisco Estuarine Institute and the Southern California Coastal Water, working with other concerned State and federal agencies, have developed a California Rapid Assessment Method (CRAM) for assessment of wetland condition to address this concern. A third concern is that, because we have not integrated compliance monitoring into our routine regulatory practice, the State and Regional Board's administrative and regulatory procedures may not adequately support effective and efficient compliance monitoring of compensation sites.

The objectives of this project are to: (1) determine project-specific and regional compliance with regulatory requirements, (2) assess wetland function and condition at the compensatory mitigation sites, (3) improve administrative and regulatory practice for establishing and monitoring conditions to regulate compensatory mitigation, and (4) determine the need for ongoing compliance monitoring.

Compensation sites in the North Coast, San Francisco Bay, Central Coast, Los Angeles, Central Valley, Lahontan, Santa Ana, Colorado Basin, and San Diego Regional Board jurisdictions were considered for the study.

The purpose of this project was to evaluate the compliance and wetland condition of compensatory wetland mitigation projects associated with §401 Water Quality Certifications throughout California. This was done by selecting, reviewing and performing field evaluations for nearly 150 permit files distributed across the 12 Water Board regions and sub-regions of the State. For each permit file we assessed the extent to which permittees complied with their mitigation conditions, including acreage requirements, whether the corresponding mitigation efforts resulted in optimal wetland condition, and if the habitat acreages gained through compensatory mitigation adequately replaced those which were lost through the permitted impacts.

The Water Boards' 401 Program was established in 1990. During the period from which permits were evaluated (1991-2002) and continuing to the present, the 401 Program has evolved. A major change was the adoption of new Program regulations, which became effective on June 24, 2000. The new regulations specified the information to be included in an application for certification, eliminated the possibility of waiving certification, identified standard conditions to be included in all certifications, and generally systematized the processing of applications. In addition, regulatory practice has evolved as field staffs have acquired experience with the Program. This study presents analysis of data representing historical practice over the study period.

1.2. Previous Studies

Wetland mitigation has been the focus of many critical studies (see Race 1985, Zentner 1988, Kentula *et al.* 1992, Holland and Kentula 1992, DeWeese and Gould 1994, Miller 1995, Mitsch and Wilson 1996, Zedler 1996, Race and Fonseca 1996, Gilman 1998, Breaux and Serefiddin 1999, Gwin *et al*. 1999, Ambrose 2000, Brown and Veneman 2001, Kelly 2001). In 2001, a panel convened by the National Academy of Sciences completed a comprehensive review of compensatory wetland mitigation in the U.S. (NRC 2001).

The work reported here follows from a number of previous studies focusing on Section 404 permits. Mary Kentula and her colleagues have conducted a series of studies exploring the effectiveness of Section 404 permitting in the United States (Kentula et al. 1992, Holland and Kentula 1992, Sifneos et al. 1992a, 1992b), including California. These studies relied solely on office reviews of permit files. In general, these studies have reported that Section 404 permits have not prevented the continued loss of wetland habitat in the U.S. However, office reviews of permit files are necessarily limited to the intent rather than actual implementation of mitigation. To remedy this limitation, a number of studies have assessed actual compliance with permit conditions in the field (see NRC 2001). In California, for example, DeWeese and Gould (1994) found 50% of the projects evaluated achieved at least 75% compliance with stated permit conditions, while Allen and Feddema (1996) identified a compliance rate of 67% in Southern California. Several studies have suggested that increased enforcement of mitigation permits would improve compliance with permit conditions (Holland and Kentula 1992, Sifneos et al. 1992a, DeWeese and Gould 1994).

A few studies have gone beyond compliance assessment to evaluate ecological condition or functions of mitigation sites. The NRC report summarizes 11 of these studies. The most relevant for our work was conducted by Mark Sudol in southern California (Sudol 1996, Sudol and Ambrose 2002). Sudol reviewed Section 404 and Section 10 permits for Orange County and conducted field assessments of each mitigation site to evaluate its compliance with permit conditions as well as how well the wetland performed certain functions (as indicated by the Hydrogeomorphic Assessment Methodology (Brinson 1993)). Sudol found 18% of the mitigation sites complied fully with their permit conditions, but that none of the sites had appropriate levels of wetland function. One of the strengths of Sudol’s work was the combination of an office review of permits with field assessments of permit compliance and wetland function/condition (Sudol and Ambrose 2002), and this approach was adopted for this study.

Most of these previous studies have focused on mitigation success solely with respect to the Section 404 permit conditions, without considering the contributions of other agencies involved in the greater regulatory process. In particular, few have investigated the successes and failures of mitigation projects with respect to the permit conditions of the Section 401 Water Quality Certification orders. Breaux et al. (2005) studied mitigation success for 20 projects near San Francisco Bay which had been regulated under the 401 and 404 programs by the local Regional Water Quality Control Board and Corps district, respectively. They found that most projects were in compliance with their permit conditions and were realizing their intended habitat functions. They reported increased habitat functional success at larger sites and argued that regulators should favor regionally integrated mitigation banks because of their improved benefits to wildlife. In a similar study commissioned by the Los Angeles Regional Water Quality Control Board, Ambrose and Lee (2004) investigated this issue within the Los Angeles/Ventura area by evaluating the mitigation projects associated with approximately 55 Section 401 permits issued by that Regional Water Board. For those projects, they found that the assessable 401 permit conditions were mostly being complied with, yet very few mitigation projects could be considered optimally functioning wetlands. About half of the total mitigation acreage consisted of drier riparian and upland habitats that were outside of jurisdictional "waters of the United States;" about two-thirds of the projects did not fully replace the functions lost, and, thus, "no net loss" was not being achieved. The present study would help determine if the findings of Ambrose and Lee (2004) are unique to the Los Angeles/Ventura Region, or if they reflect mitigation success statewide.

2. Background

2.1. Definitions and Characteristics

Definitions of wetlands and riparian areas vary widely among different groups and for different purposes. A recent NRC panel defined a wetland as below, based not on regulatory requirements but a consensus of wetland scientists; this definition provides context for the important benefits that wetland ecosystems provide:

> An ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate, and the presence of physical, chemical, and biological features reflective of that regime, such as hydric soils and hydrophytic vegetation (adapted from NRC 1995).

In general, wetlands are characterized by the presence of biophysical gradients between aquatic and terrestrial habitats and include freshwater marshes, tidal salt marshes, riverine floodplains, riparian wetlands, mangroves, and several types of depressional wetlands. These can be grouped into estuarine (tidal salt marshes), riverine (floodplains and riparian areas), lacustrine (lake affiliated), or palustrine (freshwater marshes and bogs) wetlands. The biological communities present at the various wetlands can take many forms, but one of their predominant characteristics is the presence of hydrophilic (water-loving) vegetation.

While the preceding characterization of wetlands reflects an ecological perspective, more restrictive definitions are used for regulatory purposes, with the specific definition depending on the regulatory agency. Of most relevance for this study, wetlands as defined by the U.S. Army Corps of Engineers (USACE) must generally meet a three-parameter test, having appropriate hydrology, hydric soils, and wetland vegetation. According to the USACE, wetlands are defined as:

> Wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

In addition to wetlands themselves, Section 401 and 404 permits also cover impacts to aquatic and riparian habitats falling within federally jurisdictional "waters of the U.S." and, in California, wetlands and riparian areas falling outside "waters of the U.S." may be regulated under other State laws and mandates (more discussion of jurisdictional habitats under the Clean Water Act is given later; see page 26).

Riparian habitats are defined in a non-regulatory sense as those areas that are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota (NRC 2002). They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands (NRC 2002). Riparian areas include those areas that are adjacent to perennial, intermittent, and ephemeral streams, lakes, or estuarine-marine shorelines. These habitats often line the margins or banks of streams and lakes and are characterized by the presence of low-growing hydrophytic herbs, shrubs, and tall woody trees. Much of the difference in the regulatory versus ecological definitions of wetlands that we have encountered in this study relates to variations in the definition of riparian areas.

2.2. Functions and Services

Human activities have encroached on wetlands and river systems. Vast, low-lying riverine floodplains and coastal wetlands have been key targets for human development because of the relative ease of reclamation and because of their associated fertile soils. These complex drainage systems have often been reduced to straightened channels with tall constructed banks or levees, designed to contain high flood waters. In addition, isolated wetlands have commonly been drained and filled, or converted to livestock watering areas. The result of these impacts has been the diminishment of the beneficial services that these wetland habitats provide (NRC 1995; NRC 2001; NRC 2002; Leibowitz 2003), and humans are now beginning to recognize the consequences of their loss. As a result, much of the focus of concern about the loss of wetland habitats revolves around the loss of functions and services they provide.

The functions and services[2] that wetlands and riparian areas provide fall into three broad categories: hydrology and sediment dynamics, biogeochemistry and nutrient cycling, and habitat and food web support. Each wetland type performs characteristic functions; no particular wetland performs all possible functions. A brief description of wetland functions and services follows; this is a simple overview and not a detailed catalog of all functions and services performed by wetlands.

[2] "Functions" refers to natural processes occurring in wetlands; "services" refers to processes or attributes of wetlands that are useful to humans.

2.2.1. Hydrologic Functions

Water flowing along the surface of the earth naturally flows downhill towards lower areas of the terrain and begins to accumulate in rills, rivulets, streams, and ultimately river channels as it makes its way to the ocean. Water infiltrating into the earth will also flow down-gradient through the interstitial spaces in the soil or rock, eventually emerging back at the surface in topographically lower areas. These areas where the ground water table emerges are commonly adjacent to or within stream channels. The hydraulic connectivity between precipitation source areas and re-emergence areas results in increased groundwater contributions to streams following storm events, though there is usually a modest time lag and great modulation of flow. The combined flow from overland runoff and emerging groundwater following a storm event results in a pulsed stream discharge pattern with peak flood levels occurring some time after the point of maximum precipitation. Sediment is also a significant proportion of storm runoff as soil eroded from adjacent hillsides enters the stream along with the storm water (Knighton 1998). The destructive force of the storm flow reaches the maximum at the peak of discharge, and these peak flows are what human management strategies have tried to accommodate through the construction of tall levees and often-straight concrete channels. The general philosophy has been to move the water to the ocean as fast as possible, to minimize flooding during peak flows.

But the natural geomorphology of river channels develops to accommodate these peak flows with appropriately wide floodplains and adjacent wetlands, which serve to modulate high water flow through the short term storage of water and sediment (Knighton 1998). During high flow events, water flows over the banks of the natural channel and spreads out over floodplains, where the velocity is reduced and the sediment settles out. Water percolates into soils and sediments within floodplains and riparian areas, where it is stored until the flow recedes. Then the water slowly flows back out during periods of low flow, helping to maintain baseflow conditions during the dry season[3]. Isolated depressional wetlands collect some of the water that would otherwise flow directly to the stream, thus contributing to the moderation of storm flow and the recharge of ground water. In addition, the vegetation that occurs on floodplains and in riparian zones provides mechanical flow reduction and energy dissipation of high flow, and riparian trees, shrubs, and grasses contribute to the stabilization of the stream banks. Often, the absence of riparian vegetation on the banks can lead the destabilization of the banks and their subsequent erosion and incision, though the presence of riparian trees may contribute to bank erosion in other circumstances (Lyons et al. 2000).

2.2.2. Biogeochemical Functions

Biogeochemical functions in wetlands and riparian areas include the retention and removal of substances from the water, sediment accumulation, and nutrient cycling, among others. All of these result in the overall maintenance of water quality. For example, a riparian buffer zone located between an agricultural area and a stream channel

[3] These processes are more common in low gradient streams. High gradient streams, which exhibit different hydrological functions, tend to have shallower or exposed bedrock with limited to absent floodplains and minimal surface to subsurface hydrological connections.

can absorb much of the nutrients leaching from a nearby agricultural field through either surface flow or through the groundwater (NRC 2002). These nutrients can be transformed and removed from soils (e.g., denitrification of nitrogen), adsorbed to soil particles (e.g., phosphorous),or assimilated by riparian vegetation, thus minimizing their transport to the stream. In many agricultural areas, the absence of a riparian buffer may result in direct inputs of nutrients to the stream, in which case instream wetland conditions become very important with respect to improving water quality. Many biogeochemical reactions are redox dependent. That is, certain reactions occur in the presence of oxygen while others require the absence of oxygen. Many of the beneficial reactions that contribute to the improvement of water quality, such as denitrification or the transformation of contaminants, require the absence of oxygen (Casey et al. 1986, Reddy and D'Angelo 1997).

2.2.3. Ecological Functions

Wetlands are extremely important habitats for migratory birds, which use them for resting and feeding areas as they travel from place to place or for breeding. Wetlands and riparian areas are also important to many other species of plants and animals, including threatened and endangered species, and can be areas of notably high biodiversity. For example, riparian habitats in the Santa Monica Mountains cover less than 1% of the land area yet are the primary habitat for 20% of the higher plant species (Rundel 2002). In today's heavily fragmented landscape, riparian areas can be extremely important corridors for the movement of animals. Many isolated wetlands that become dry during part of the year cannot support fish species, making them important habitats for reptiles and amphibians that would otherwise be preyed upon by fish (Gibbons 2003). Further, riparian trees and other vegetation perform important shading functions, providing significant thermal regulation for the community by keeping water and air temperatures cool during warm dry periods.

2.3. The Protection of Wetlands

When Europeans first arrived in North America, the vast amount of dense woodland and wetland habitat constituted substantial impediments to the settlement of the land (Hawke 1989). Throughout most of our nation's history, the federal government actively encouraged the conversion of wetlands for useful purposes and for disease abatement, as evidenced by legislation such as the Federal Swamp Land Act of 1850, which promoted their conversion to agricultural land (NRC 1995). The notion that wetlands perform functions or services that can be beneficial to the greater human society has only taken root within the last several decades. Among the suite of landmark environmental laws passed in late 1960's and early 1970's was the Clean Water Act, which had the ambitious goal "to protect the physical, chemical and biological integrity of the nation's waters" (NRC 2001).

While the main focus of the Clean Water Act was to prevent water pollution, some aspects of this law extended protection to wetlands, and these remain the most important federal protections for wetlands today. Wetland protections came primarily under Section 404 of the CWA, in which the U.S. Army Corps of Engineers was made responsible for regulating the discharge of dredged or fill material into "waters of the

United States," including wetlands, under the general oversight of the EPA. Under CWA Section 404, restoration and creation practices were to be employed to compensate for impacts to wetlands. Wetlands are often located wholly or partially on privately owned land. This aspect of wetland regulations have made them some of the most contentious elements of environmental law to date (NRC 1995), and the resulting protection of wetland habitat has fallen short of the goals set forth in the Clean Water Act (NRC 2001).

By the mid 1980's, wetland declines had resulted in the loss of approximately 117 million acres of wetlands nationwide, about half the original amount (NRC 1995). In California, declines were much more severe with losses estimated to be about 90%.(Dahl 1990) Recognizing this problem, and given the refined understanding of the importance of wetland functions, the EPA called for a National Wetlands Policy Forum in 1987 and asked the participants to make national policy suggestions for the future of wetland protection. The central recommendation of the panel was to create a policy of "no net loss" of remaining wetlands which would be emphasized in the Corps' Section 404 permitting program. In 1990, the first Bush administration adopted this policy of "no net loss." Later that year the Corps and EPA produced a guidance document that instructed regulatory personnel how to implement compensatory mitigation requirements (see below) within their 404 permit program such that "no net loss" would be achieved (NRC 2001). The implementation of this policy goal, along with a stronger emphasis on compensatory mitigation practices to offset wetland losses, took effect in 1991.

2.4. Clean Water Act Sections 404 and 401

Section 404 of the Clean Water Act prohibits the discharge of dredged or fill material such as sand or soil into "waters of the United States," unless a permit is issued under the regulatory authority of the U.S. Army Corps of Engineers. The great majority of permit applications are ultimately approved (NRC 2001). While some projects must be evaluated and permitted on an individual basis, others may fall into more general categories, such as bank stabilization or the maintenance of bridge over-crossings. Numerous regional or nationwide permit categories are available for such projects, which can help to streamline the approval process. With the exception of some nationwide permits, Corps personnel must follow a standard three-step sequence in their decision making process. They must first determine if different strategies could be employed in which all or some of the proposed impacts might be avoided or minimized. Given the national goal of "no net loss," any remaining impacts must be compensated for by creating, restoring, or preserving wetlands or waters in another location (NRC 2001). This is termed *compensatory mitigation*.

With respect to compensatory mitigation, agency guidance documents and regulatory personnel have traditionally preferred nearby, in-kind mitigation to offset losses. However, recognizing the shortcomings of some permittee-responsible mitigation, federal and state agencies have developed policies for the use of alternative third-party strategies such as *mitigation banks* and *in-lieu fee programs* where mitigation is likely to be off-site (NRC 2001).

Mitigation banks are sites where a large restoration, creation, or enhancement project, is undertaken to provide compensatory mitigation in advance of projects that will create wetland losses.[4] Credits from these projects can be used to offset losses (debits) permitted under Section 404 on an acreage basis. Mitigation banks may be established by entities that anticipate having large numbers of future permit applications, or by third parties that wish to sell their credits for a profit. Although there is a formal process for establishing mitigation banks, some of the mitigation banks used by permittees with a large number of permits are only informal banks, having never been established through the formal process but nonetheless being used by the permittee and regulatory agencies as a bank. In-lieu fees are payments made to natural resource management entities for implementation of either specific or general wetland development projects.[5] Mitigation banks have the benefit of avoiding temporal losses of wetland habitat that occur between the time the actual loss occurs at the impact site and the point where complete function is restored at the mitigation site. In-lieu fee programs may or may not avoid temporal losses. Both of these third-party approaches have the potential to restore large areas of relatively high quality contiguous wetland habitat that may be better situated in a landscape context than individual mitigation projects, being placed in proximity to existing functional wetland habitat. However, banks and in-lieu fees often result in off-site mitigation, with potential negative effects due to spatial shifts in habitat distributions and loss of wetlands within some regions. In addition, the values wetlands provide often are dependent upon their location in the landscape, such as their position relative to one another, to adjacent waters, and to the human population that would benefit from the services provided (Brown and Lant 1999).

Most often, the amount of mitigation required is not a simple one-acre mitigated for one-acre lost ratio (NRC 2001). The additional acreage is intended to account for temporal losses and incomplete replacement of function. Therefore, mitigation ratios of 2:1, 3:1, or greater are sometimes required.

Every applicant for a 404 permit must also obtain a *state water quality certification* required under CWA Section 401, which, in California, is administered by the State Water Resources Control Board and its nine Regional Water Boards[6]. This document certifies that the project will not adversely impact water quality, or if it does, those impacts will be mitigated. In addition, if there will be impacts to river or stream courses, the applicant must enter into a *streambed alteration agreement* with the California Department of Fish and Game (DFG), and if impacts to threatened or endangered species may occur, a biological opinion will be issued from the United States Fish and Wildlife service; these regulations ensure that the project does not adversely impact the local fish and wildlife, or if it does, those impacts are mitigated. Other state or federal regulatory agencies may play a role as well. While each agency treats their mitigation requirements as separate and distinct, the applicant usually blends all agency requirements together into a single mitigation project.

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[4] Of course, there are many variations on this general description, a common variant being allowing credits from a mitigation bank before it is completed and demonstrated to be successful.

[5] In the past, in-lieu fees were not necessarily restricted to natural resource management, and as a result became a controversial form of mitigation. For example, in-lieu fees used for general administrative expenses at an agency do nothing to replace lost natural resources.

[6] The administration and implementation of CWA Section 401 varies from state to state; California is among those states with more developed 401 programs.

Some wetlands and riparian habitats are considered non-jurisdictional by the Corps and therefore are not regulated under CWA Sections 404 and 401. In California these habitats may be considered "waters of the State" and be regulated under the Porter-Cologne Act and other State laws, policies and regulations. In recent years the jurisdictional authority of the Corps has been reduced by several Supreme Court decisions; as a result, "waters of the State" determinations have become a more critical part of comprehensive wetland protection, with compensatory mitigation required for any regulated impacts to these state-regulated resources.

Aside from CWA Section 401, there are a number of means by which the State and Regional Boards regulate impacts to wetlands and other aquatic resources. Examples are the National Pollution Discharge Elimination System (NPDES) permits, which regulate point source discharges, Waste Discharge Requirement (WDR) permits, which can regulate both point source and non-point source pollutant discharges, and the best management practices (BMPs) required under their Storm Water permitting program. Storm water BMPs can include large detention basins and treatment wetlands that can provide substantial compensation for hydrological and biogeochemical impacts, but these are treated separately from other compensatory mitigation requirements associated with Section 401 permits. Waste Discharge Requirements, however, are often combined with the Section 401 requirements into a single joint permit. Through CWA Section 401, these other regulatory programs, and, more generally, through a series of Water Quality Control Plans (Basin Plans), the state and regional boards attempt to ensure that water quality standards (beneficial uses, water quality criteria, antidegradation policies) will be met.

2.5. Assessing mitigation success

After a permit is issued, monitoring of the mitigation site is almost always required; however, there is generally little regulatory follow up evaluating what happened at either the impact site or the mitigation site. This is, in part, because there are so few regulatory staff and so many permit applications (NRC 2001). Mitigation reports typically are required to be submitted by the permittee throughout the certification period, but it is not clear how often this is done or how often regulatory staff review them. In addition, record keeping has been identified as an impediment to assessing mitigation practices, with incomplete files and inadequate database tracking systems being a common regulatory problem (NRC 2001, Ambrose and Lee 2004).

Few determinations of the regulatory success of compensatory mitigation projects occurred during the first decade of their existence (NRC 2001). Determining mitigation compliance can be difficult. Assessing permit compliance entails an initial permit review and site visit to determine if the project was undertaken, if the actual acreage matched what was proposed, and if the specified performance standards were met. In planning and executing a compensatory mitigation project, the permittee's focus usually is to satisfy permit conditions. As long as the permittee can demonstrate that the performance standards set forth in the permit have been met, their obligations have been fulfilled. As yet, aspects of wetland function have not been adequately incorporated in performance standards (NRC 2001, Ambrose and Lee 2004), in part because of the legal difficulties in assigning specific targets for function (NRC 2001). Some performance standards that have been developed are intended to be proxies for function, but given the challenges of measuring functions directly, assessments of hydrological, biogeochemical, and ecological function have remained elusive.

Data reported by the Army Corps of Engineers indicate that the goal of “no net loss,” as measured by acreage shifts, is not only being met but is being exceeded. According to the Corps, from 1993 through 2000, approximately 24,000 acres of wetland losses were permitted, while 42,000 acres were created through compensatory mitigation (NRC 2001). Thus an average mitigation ratio of 1.8:1 was achieved. However, these statements of mitigation success and the achievement of “no net loss” were based solely on the acreage of mitigation *required in the permits*, not on field evaluations of wetland acreage or function present at mitigation sites. In addition, they may have not included existing acreage of wetlands at mitigation sites. Furthermore, they have not addressed functions provided at mitigation sites. One recent study that employed functional assessment methods to evaluate the success of the Section 404 permitting program, conservatively estimated that only 55% of mitigation sites met permit conditions, while only 16% of the sites could be considered successful in terms of function (Sudol and Ambrose 2002). Another study, Ambrose and Lee (2004), found that the majority of mitigation projects met their mitigation acreage requirements and most were in compliance with permit requirements overall, yet few (4%) resulted in optimally functioning wetlands and, with respect to a structured qualitative assessment of the beneficial services lost versus those gained through the mitigation project, 66% failed to achieve “no net loss.” These data suggest that the success of the Clean Water Act and the “no net loss” policy has not succeeded in preserving our nation’s remaining wetlands. It is impossible, however, to determine the extent of wetland losses that would have occurred in the absence of the Section 404 program.

3. Methods

3.1. Project Management

This statewide study was conducted by two research groups: a University of California, Los Angeles (UCLA) research group consisting of Dr. Richard Ambrose (principal investigator), two full-time research technicians, three shorter-term technicians, and one graduate student/project coordinator (Steven Lee), and a University of San Francisco (USF) research group consisting of Dr. John Callaway (principle investigator), three graduate student researchers working full-time and one shorter term technician.

The Principal Investigators maintained oversight over the entire project, including project conception and design and completing the final report. UCLA had primary responsibility for contract administration and project management, project coordination and management, the initial SWRCB database review, regional apportionment and selection of permit files for review, Freedom of Information Act (FOIA) coordination, and progress report generation. The permit review and field efforts for this project were roughly equally divided between the USF and UCLA groups, with USF responsible for the northern half of the state and UCLA the southern half. Considerable effort was spent ensuring consistency between USF and UCLA data collection procedures. Members of the UCLA group participated in the initial file review for the north-central portion of the

State and joined the USF group for a number of their field reconnaissance visits and site evaluations, and a member of the USF group participated in some site evaluations conducted by UCLA. After the fieldwork was completed, UCLA was responsible for data management, data analysis and presentation, and producing the initial draft of the final report. UCLA carried out most of the QA/QC procedures and, after finding a range of data and consistency problems, helped the USF group resolve these issues. The USF group incorporated the site GPS coordinates into GIS base maps to create regional and statewide maps showing the distribution of our mitigation site assessments. In addition, the USF group completed an analysis of mitigation banks (see Appendix 9) and a supplemental assessment of wetland condition (the Wetland Ecological Assessment, or WEA) at a subset of their sites and carried out all analyses and reporting of those data (see Appendix 10).

3.2. Permit File Selection and Review

For this study, our goal was to evaluate the mitigation actions associated with at least 100 Section 401 permit files issued in California between 1991 and 2002. The projects were to be distributed across the 12 regions and sub-regions of the State Water Resources Control Board (SWRCB) in proportion to the total number of 401 permit actions issued within each region (Figure 1). For instance, if a particular region had issued 10% of the total statewide 401 permits in this timeframe, then 10% of our evaluations occurred in that region. The regional targets were exceeded for all regions except for Redding (5R) and Lake Tahoe (6T), for which we met the targets exactly. For those regions with small proportional targets (Region 7 and sub-Regions 5F, 6T, and 6V), we attempted to add more files to increase the sample sizes, but this only was achieved for sub-Region 5F.

Files were selected using the SWRCB's permit tracking database. We used the version dated October, 2004, obtained directly from the State Board. To ensure statistically reliable information, projects were chosen randomly from this database. Initially, we expected to select all projects based on the database fields that indicated compensatory mitigation was required. However, we discovered that the database did not reliably indicate a compensatory mitigation requirement for permits issued before 1998; for these files, a physical inspection of a large number of files at the State Board office was necessary in order to find the appropriate number of projects requiring mitigation. To account for the difference in information in the database as well as ensure an equal distribution between older and more recent permits, half of the projects were from 1991-1998 and half were from 1998-2002. The permit projects included in our study included 401 permits with explicit mitigation conditions as well as permits without conditions but with implicit or explicit requirements that the mitigation conditions of other regulatory agencies be followed. The permit projects were reviewed through multiple visits to the SWRCB, each of the three Army Corps of Engineers district offices (Los Angeles, San Francisco, and Sacramento), and various Regional Boards. There were many complications that had to be resolved in selecting files for this study; a full accounting of the selection process is provided in Appendix 1.

3.3. Office Review and Assessment

After the initial permit review at the Corps and/or Regional Board offices, the relevant file materials were photocopied and retained for further review and for reference during field visits. Prior to the field visit, each file was subjected to an extensive office review to verify that the project occurred, to gain a general understanding of both the project impact and the expected mitigation activities, and to extract all relevant permit conditions for the ensuing compliance evaluation. To this end, all available documentation was consulted, including any pre-project planning information, the 401 order, 404 permit, streambed alteration agreement, mitigation plan, monitoring reports, and any other information reflecting changes in the planned actions since the permits were issued. Often, correspondence with regulatory personnel, the permittee, the permittee's consultant, or the in-lieu fee recipient was necessary to resolve site access issues, to determine if the impact or mitigation projects were undertaken, or to verify fee payments.

Office evaluations were a significant element of the condition assessment methodology (discussed below); the information gained from this evaluation improved the understanding of the landscape context of the site, including the surrounding land uses and the stressors associated with those land uses and helped to identify the boundaries of the assessment area. One important component of the office review was the acquisition of web based aerial photographs (http://terraserver.microsoft.com/), which provided landscape context and aided in the location of project sites.

As we performed the office reviews, some files were deemed un-assessable and were excluded from further study. Reasons for such exclusion varied but included confirmation that the impact and/or mitigation project never happened and denial of access to the project site.

3.4. Site Visits

Given the broad geographic scope of this statewide study, combined with the time limitation imposed by the contract and the protracted permit review process, logistics and efficiency were critical aspects of the field phase of the project. Early site visits and methodological refinements occurred close to the home bases of the two research groups; more distant sites were assessed later. Once the assessment procedures were established and the initial list of permit files was obtained, the project locations were marked on state and regional maps and organized into local or multi-day research trips based on the proximity and clustering of the sites. Substantial effort was put into planning field work to maximize efficient use of time in the field. Seasonal and other factors were considered, and the trip clusters were prioritized and scheduled. In advance of a trip, the relevant files were reviewed, the permit conditions extracted, data forms were generated, access issues were anticipated and pursued, and other logistical arrangements were made.

Upon arrival at the general project area or the mitigation site location, we looked for evidence of mitigation activities such as plantings, irrigation systems or disturbed earth to confirm the presence of mitigation activities. The permit paperwork and aerial photographs were helpful in establishing the presence of the mitigation site and determining its boundaries. For each of the fully assessed files, a considerable amount of time was spent onsite deciphering the language of the permit file paperwork to understand the nature of the impacts, to identify all discrete mitigation projects involved, to identify and map the boundaries of those discrete projects. Following regulatory conventions, a site was considered onsite if it was on the same property as the impact, and this determination was relative to the scale of the greater project area. For a large development project, two mitigation actions located a kilometer or more apart could both be considered onsite, while the mitigation site for a small utility crossing might be considered offsite even if separated by just 100m.

Occasionally, we found that the impact project was currently under construction and the mitigation activities had not yet been initiated, or there was no evidence that the impact or mitigation project occurred. It was also common, especially with the newer permits, that the impact project had occurred, but the construction of the mitigation site was still under way. There were a few instances where the impact project had been completed, but we found no evidence that the required mitigation had occurred. In each of these cases, the file was excluded from further consideration in this study. A list of all such files with the reasons for exclusion has been provided separately to the SWRCB. In addition to these excluded permit files, there were 14 files for which compliance evaluations could be made, but where wetland condition evaluations were not performed either because of ambiguities inherent in the mitigation banking and/or in-lieu fee process or for logistical reasons. These files, provided in Appendix 2, are included in our compliance results but not the results of our condition evaluations. We refer to these 14 files as “compliance only” files, while files that were evaluated for permit compliance, acreage, and wetland condition (CRAM) are referred to as “fully assessed” files.

3.5. Acreage Determinations using GPS

The acreages of mitigation sites were determined by mapping the perimeter of each site. After initial site reconnaissance, we walked the site perimeter using a mapping grade GPS to establish the outline of the site. GPS data were collected with a Trimble Pro XR GPS receiver and a TSCE handheld interface. Many permits (70 of the 129 permit files we assessed) involved multiple mitigation sites. In these cases, we surveyed and evaluated the discrete mitigation sites separately.

Although simple in concept, the actual acreage determinations were complex. The reasons for this are varied. In many permits, there were ambiguities in the identification of mitigation habitat types and no site positioning information. The boundary between mitigation wetlands and adjacent existing wetlands was often not easily discerned. Many mitigation project sites blended together several different habitat types (e.g., wetlands, alluvial scrub, riparian areas, etc.). In addition, multiple mitigation strategies were often used (e.g., creation, restoration, enhancement, and preservation) and were difficult to distinguish. Even where site boundaries could be determined, they were usually not clearly delineated as they transitioned into the surrounding landscape. GPS coordinates of mitigation sites were almost never available in the permit files, and stakes, flags or other survey markers were seldom present. We attempted to be as accurate as possible in our surveys of site perimeters, but we erred toward overestimation rather than underestimation of site area. That is, we walked the widest boundary possible as determined by disturbed earth, irrigation systems or obvious vegetation plantings to provide a "best case" acreage estimate.

We were sometimes unable to determine even the approximate boundaries of a mitigation site. (See Section 6.2.1.7 for a recommendation to address this problem.) This was common for older sites and for re-vegetation projects in active channels or floodplains. When the evidence of mitigation activities was scant or absent, and when these activities blended into the surrounding landscape, it was not possible to delineate the perimeter of the project site. We attempted to confirm the general location of the mitigation site from evidence of mitigation activities at the expected site location and/or through information gleaned from the permit files. If it was possible to confirm a general location for the mitigation site, a single GPS point was taken to identify the approximate location of the site and our corresponding evaluations.

After field mapping, GPS data were downloaded to office computers and managed using Trimble's Pathfinder Office Version 3.0 software. GPS data were differentially corrected (yielding sub-meter accuracy) using data collected from the base station provider nearest to the mitigation site, as determined by an automated internet search. The acreage values were obtained from the corrected files within Pathfinder Office. Occasionally small perimeter adjustments were made to these files or polygon fragments were added or subtracted using the measuring tool function in that program. Acreage values were recorded and compared to the permit requirements to determine acreage compliance. There may have been a number of discrete mitigation sites associated with a file, and these were mapped separately. However, permit requirements generally included only a single acreage requirement per file (or per habitat type), so we combined the acreages of separate mitigation sites to determine compliance.

In situations where the site perimeters were clear and unambiguous, we always reported our survey values as the obtained acreage. However, where the site perimeters were less clear, and especially where single GPS points were taken, a judgment had to be made to determine whether there was compliance with acreage requirements. In such cases, we considered all available information, including visible features of the site and information from the permit file such as acreage values reported in mitigation plans and monitoring reports, to judge whether the acreage requirement was met. Ultimately, a decision regarding acreage compliance was made for all files with acreage requirements. It should be noted that the target acreage outlined in the mitigation plan is intended to compensate for all agency requirements (including the Army Corps, and CA Dept. of Fish and Game), and often exceeds that required by the 401 permit alone.

For every file, a single representative GPS coordinate was selected and recorded in Pathfinder as the best description of the location of the mitigation sites (Appendix 4). Also included in this appendix is a compact disc containing all GPS-related computer files associated with this project.

3.6. Compliance Evaluations

In theory, permit compliance would be determined by considering each of the specific and general conditions listed in an agency's permit, assessing whether each condition had been met or not met, and then assigning an overall compliance score based on the percentage of conditions met. In practice, a third party assessment of permit compliance, especially one that attempts to follow the standard conventions of scientific rigor, is complicated by the idiosyncratic nature of regulatory permits in which each project is unique and there is little standardization in the wording of permit conditions.

Most of the conditions listed in 401 orders were administrative in nature or involved impact avoidance measures to be implemented during the construction phase of the impact and mitigation projects. This was especially true of the standard conditions that are often attached to the 401 order, but many of the special conditions fell into this category as well. Most of these conditions were impossible to assess in an after-the-fact review, such as the present study, because one would need to be present during the construction phase or have detailed post-construction compliance reports documenting how each condition had been satisfied. While compliance monitoring reports were often required, they were infrequently available.

Since the focus of this study was on the success of compensatory mitigation projects, the conditions we considered in our compliance evaluation were limited to those dictating the mitigation actions to be taken, any performance standards meant to ensure the success of the mitigation project, and any submission requirements for mitigation-related documents. The 401 permits we reviewed included relatively few conditions in these categories. The most commonly encountered were descriptions of the proposed mitigation actions and acreages, submission requirements, references to the mitigation plan or specific phraseology that the plan be followed, and conditions invoking the permit requirements of other regulatory agencies (e.g., the 404 permit issued by the U.S. Army Corps of Engineers, the Streambed Alteration Agreement issued by the California Department of Fish and Game (DFG), and occasionally, other agency requirements such as those specified in the U.S. Fish and Wildlife Service (FWS) Biological Opinion).

Our determinations of 401compliance included all mitigation conditions specifically outlined in the 401 permit order, plus any additional compliance goals or conditions found in the mitigation plan and other agency permits when the 401 permit included explicit statements requiring that those documents be followed. With respect to the mitigation plan, if the 401 permit contained a submission requirement or included language indicating that the plan had already been obtained and reviewed by the Regional Board prior to permit issuance, we considered it to be implied and enforceable that the plan be followed as a condition of the permit. We did not consider other agency requirements as implied and enforceable conditions of the 401 permit unless there was specific language mandating that those permits be followed. At the same time, we recognized that during the mitigation planning process, the permittee must consider all agency requirements (not just the 401), and that the mitigation plan represents a blending together of these conditions into a single project. Therefore, we completed a second compliance evaluation that considered how well the assessable goals and performance standards of the mitigation plan were met. In addition, in the field we assessed compliance with all agency conditions contained in the file, even for permits not explicitly invoked by the 401 order. Due to time limitations and the fact that these latter analyses were beyond the contractual scope of this project, they are not included in this report.

As part of our general office assessment, each permit file was subjected to a thorough review during which all appropriate mitigation requirements were extracted from the available paperwork. Beginning with the 401 order, each regulatory permit was carefully read to allow for a full understanding of the project requirements and to distinguish mitigation-related conditions from the other conditions of the permit. All relevant conditions were entered into a Microsoft Access database and tracked according to the source permit. Many of these conditions were entered verbatim, but it was often necessary to paraphrase or dissect the permit text because the permit requirements were written in an ambiguous fashion or not amenable to a direct assessment of compliance. (See Sections 6.3.2 and 6.3.3 for recommendations the deal with this issue.) For example, a single line-item condition including two or more discrete requirements that could not easily be assessed or scored together would be separated into assessable conditions. In other cases, long passages were condensed down to the essential compliance elements. All relevant mitigation-related conditions were entered, even conditions that would likely be un-assessable.

In addition to the regulatory permits, the mitigation plan, if present, was carefully read to extract the essential compliance elements. Though it may implicitly or explicitly be mandated that the mitigation plan be followed as a condition of the permit, there is no simple prescription for assessing mitigation plan compliance. Mitigation plans must be prepared and submitted by applicants in a format that has been dictated by the RWQCB and the Corps; however, they are highly variable in their presentation. Mitigation plans are not written as lists of assessable conditions; both permit-mandated and permittee-initiated objectives, actions, and success criteria are blended together and presented diffusely throughout the pages of the mitigation plan. (See Section 6.3.3 for a recommendation addressing this issue.) This complication required that we establish criteria for extracting discrete compliance elements from the mitigation plans. A full accounting of these conventions and lists of typical conditions extracted are presented in Appendix 6. All relevant objectives, actions, and success criteria taken from the mitigation plans were entered into our Access database and recorded as coming from the mitigation plan.

Prior to the field visit, lists of conditions by source were printed as data sheets and permit conditions were assessed for compliance through a combination of field and office assessments. There are at least two equally justifiable methods of assessing permit compliance. The first is to score each condition as either met or not met, and to calculate an overall compliance score as the percentage of conditions met. This approach is consistent with the regulatory perspective and has been used in other studies of mitigation compliance (e.g., Sudol 1996). The approach employed in this study departed from this met-not met perspective because we recognized that permittees may attempt to meet a particular condition even if they fall short of the success criterion needed to meet that condition to 100% satisfaction. In other words, a *not met* score does not allow the distinction between a permittee who obtained 95% of the required mitigation acreage and a permittee who made no mitigation attempts at all. Since our goal was to understand the critical factors influencing compliance success, we were interested in incorporating this distinction. Thus, we scored each condition as a percentage on a scale from 0% (no attempt to comply) to 100% (condition fully met).

In most cases, compliance was assessed within five scoring categories: 100%, 75%, 50%, 25%, and 0%. A 100% score was assigned if the condition had been clearly met or exceeded. The 75% scoring category was applied if the condition fell short of being fully met, but had been mostly met. If the condition was about half, or partially met, it received a 50% score. The 25% category was used if some level of compliance effort had been made, but the outcome fell far short of expectations, and the condition was mostly not met. Finally, a 0% score was assigned if there was clear evidence that the permittee made no effort to comply with the condition. These broad categories were used to distinguish different degrees of compliance with a particular condition but avoid difficulties that could arise from trying to distinguish between fine-scale categories (e.g., 85% versus 90% compliance).

For some conditions, the score could readily be calculated as a percentage relative to the desired outcome. For instance, if the target mitigation acreage was 0.75 acres but our surveys revealed that only 0.50 acres had been obtained, then the compliance score would be 67% (0.50/0.75). Acreage compliance was almost always calculated in this way. This approach was used for other variables that were continuous in nature (such as survivorship or percent cover), but only when our assessments could be made with a high degree of certainty. Otherwise, the condition was assessed using the above scoring categories. Some sites that we evaluated were only recently restored, and it would not be appropriate to evaluate these using final criteria in permits or mitigation plans. In these cases, we evaluated sites according to interim success standards that were identified in mitigation plans (e.g., 50% cover by year 3, 75% cover by year 5, etc.).

In scoring compliance, we were careful to distinguish between compliance with the explicit verbiage of the condition and the ecological outcome that the condition was directed towards. For example, if a condition required that “non-natives be removed prior to planting,” then as long as we found evidence that this task was done, the condition would be assigned a high score, even if the site was currently dominated by non-natives. However, if the condition required that “non-natives be eradicated from the site,” then a site dominated by non-natives would yield a low score.

A large number of mitigation conditions could not be assessed because there was not enough evidence to confirm or deny that a required action had been taken. In such cases, we had no choice but to score the condition as “not determinable.” These conditions were not included in our analyses of overall compliance score. Many of these conditions could not be assessed because one would have had to be present during project implementation or have access to detailed information verifying compliance. For example, it is commonly required that any non-native species be removed prior to restoration, stripped or exposed areas be hydroseeded with native grasses, and mulch applied around plantings. Sites rarely contain evidence of such activities a few years after construction, so without photo-documentation or written verification, none of these conditions can be assessed in an after-the-fact review such as the present study. A full accounting of the compliance issues we experienced, along with our resolutions and scoring conventions, is provided in Appendix 6.

3.7. Evaluations of Wetland Condition

3.7.1. California Rapid Assessment Method (CRAM)

Permit compliance alone may not guarantee that mitigation actions result in ecologically functional wetlands or riparian habitats. To evaluate existing wetland condition, we performed the California Rapid Assessment Method (CRAM; Collins et al. 2005) at all assessable compensatory mitigation sites associated with our permit files. CRAM is a semi-quantitative method for the rapid assessment of wetland and riparian condition. The following excerpts from the CRAM 3.0 manual (Collins et al. 2005), with some paraphrasing, provides the basic conceptual framework of this methodology:

> The objectives of CRAM development are to provide a rapid, scientifically defensible, and repeatable [assessment of wetland condition] that can be used routinely in wetland monitoring and assessment programs, [notably in the] evaluation of wetland restoration project performance under the Coastal Zone Management Act, Section 1600-1607 of the California Fish and Game Code, Sections 401 and 404 of the Clean Water Act, and local government wetland regulations, [and in the] assessment of restoration or mitigation progress relative to ambient conditions, reference conditions, and expected ecological trajectories.
>
> The CRAM methodology consists of scoring wetlands of any of several different classes based on four attributes: hydrology, biotic structure, physical structure, and buffer/landscape context. Within each of these attributes are a number of metrics that address more specific aspects of wetland condition. Each of the metrics is assigned a score based on either narrative or schematic descriptions of condition, or thresholds across continuous, numerical values. Scores assigned are aggregated up to the level of attributes as well as into a single, overall score. In addition to assessing wetland condition, CRAM provides the practitioner with guidelines for determining the types of stressors that may be affecting a given wetland, and may therefore help explain low condition scores.

To clarify terminology that is used throughout the report, we have adopted the use of the two key terms from CRAM methodology: *attributes* represent the four major areas that are evaluated in CRAM (hydrology, biotic structure, physical structure, and buffer/landscape context), whereas, *metrics* are the specific parameters that are scored in the field within a particular attribute. There may be anywhere from two to six metrics per attribute.

During our previous study of mitigation success (Ambrose and Lee 2004), we used an earlier version of CRAM (CRAM Version 2.0; Collins et al. 2004) to evaluate wetland condition at mitigation sites in SWRCB Region 4 (Los Angeles/Ventura). At the time of that study, CRAM was in an intermediate stage of development and some aspects of the method had not been resolved. We made a number of modifications to that version of CRAM to improve its utility for evaluating mitigation wetland sites, many of which were subsequently incorporated into CRAM. By the beginning of the present study, a new draft version of CRAM was available and ready for field calibration. Early in the project, the UCLA and USF research groups participated in a calibration meeting that included several field tests of the revised method. Issues identified during that calibration meeting were incorporated into the new version (Version 3.0, Collins et al. 2005), which was distributed to the CRAM calibration teams for further field testing. As we entered the fieldwork phase of this study, we began using CRAM 3.0 in our site evaluations. During the course of this study, a few additional modifications were proposed by members of the CRAM development team and an unofficial revision of CRAM (termed Version 3.5) was implemented. We adopted the proposed modifications and incorporated them into our remaining site evaluations; we also rescored all previous evaluations to ensure consistency among all mitigation site assessments. Subsequently, CRAM has continued to evolve with newer versions (see www.cramwetlands.org for more information on CRAM).

Despite changes to CRAM incorporated after our study for Regional Board 4, the delineation of the assessment area still required modification or adaptation. CRAM was designed to evaluate complete wetland systems, including larger estuarine or depressional wetland complexes or for riverine sites, the entire riparian zone consisting of the stream channel and the vegetation along both banks. However, mitigation sites are rarely complete wetland systems. For example, it was very common for riparian mitigation projects to occur outside the active channel and to involve plantings along only a single bank, or within an area above the bank that previously was upland habitat. While CRAM has rules for establishing the limits of the assessment area (including the appropriate reach length and the lateral limits of the riparian zone), our assessment areas had to conform to the boundaries of the mitigation sites. Thus, if the mitigation efforts occurred on a single bank, most of our ecological evaluations (such as plant cover) would be limited to that bank area alone. However, several aspects of the riverine CRAM evaluation were dependent upon the characteristics of the main stream channel. Specifically, the assessment criteria for all three hydrology metrics (water source, hydroperiod, and upland connection), two of the abiotic structure metrics (abiotic patch richness and topographic complexity), and two of the biotic structure metrics (biotic patch richness, and interspersion and zonation) were focused on channel and floodplain characteristics. If CRAM was applied strictly, assessment areas that did not include the stream channel would always score poorly for those metrics. However, we adopted the convention to consider the channel as part of the assessment area for these metrics, provided that the mitigation site was in direct proximity to, and hydrologically connected with, the stream channel. As a result of this approach, riparian mitigation sites or portions of sites that occurred high on channel banks, and were clearly not wetlands, received relatively higher scores for these metrics than they would have with a more strict application of the CRAM assessment area. While this may have inflated the CRAM scores for some mitigation sites, we adopted this convention to allow mitigation sites adjacent to a stream channel to be assessed as part of the entire riverine system, even if the mitigation action did not alter the channel. Furthermore, this was consistent with the approach used earlier by Ambrose and Lee (2004). Mitigation sites that were not directly associated with a channel, such as "riparian" plantings in upland areas above and beyond the banks, were scored using the standard definition of CRAM assessment areas since there was no clear connection to a channel; such sites received the lowest scores for channel-dependent metrics. Aside from this convention for including channel characteristics in the evaluation of riparian sites, all other aspects of CRAM related solely to the actual site of the mitigation actions.

For every file, we determined whether the permit requirements resulted in one or more mitigation projects that could be assessed appropriately using CRAM through our permit review, site reconnaissance, and compliance investigations. Restoration, creation, and enhancement projects that were post-construction and for which the initial vegetation efforts had been made were evaluated using CRAM. As a convention, we did not perform CRAM at any wetland preservation or conservation sites because there was no mitigation *action* to assess. Such files were evaluated for compliance only (e.g., payment of fees).

When a permit file contained a single discrete mitigation site, a single CRAM evaluation was made. Many files, however, included two or more distinct sites involving fundamentally different habitats or mitigation strategies. For example, the mitigation requirements of a given file might include a depressional wetland creation project and a riparian restoration project, or the file might include two separate "riparian" sites, one of which involved the reconfiguration and planting of a stream bank while the other involved "riparian" plantings in a separate location that was beyond the stream banks in an upland area. As another example, a file might involve mitigation bank payments for both tidal wetland and seasonal wetland credits. Separate CRAM evaluations were done for each of these distinct mitigation sites.

When an individual mitigation site was small and homogeneous, we assessed the entire site with a single CRAM evaluation. If the site was larger and more complex but a central location appeared to be representative of the entire site, we performed a single CRAM evaluation in the central location. However, there were many mitigation sites that were so large and/or complex that we needed to perform two or more CRAM evaluations in different locations in order to characterize the entire site. Decisions about how to subsample were dictated by the physical and biological features of the sites. For example, if a site consisted of a series of excavated wetland depressions occurring diffusely throughout the site or in groupings across the general mitigation project area, we would assign numbers to each of the depressions and randomly select two or more individual sites to evaluate. Alternatively, we would break the site into like groupings and randomly subsample one depression per grouping. As another example, for a long and complex stream/riparian system that was too extensive to integrate into a single CRAM evaluation, we might perform three separate evaluations, one at each end and one in the middle of the reach. Often, up to five or more evaluations were performed for a single mitigation site. In all cases where multiple CRAM assessments were made for a single mitigation site, the CRAM scores were averaged to arrive at a single CRAM per site.

One change that occurred between the earlier version of CRAM used in Ambrose and Lee (2004) and CRAM 3.0 was an increased emphasis on assessing the vegetation community at the site. The greater level of detail required for the identification of individual plant species and the determination of the relative percent cover for each species added considerable time to the field evaluations, demanded increased expertise regarding the statewide flora, and created complications in the assessment of the percent invasive plant species and native plant species richness metrics. The consistent identification of plants to a given taxonomic level was problematic for such a large study. We attempted to identify all plants to the species level; however, for some specimens, we were only able to reach the genus or family level. For specimens that could not be identified in our field visits across the state, we photographed or collected plant samples that could be later identified in the lab or with the assistance of local experts. Cover estimates for unidentified species were made in the field and placeholder names were replaced when samples were identified. Grasses were particularly challenging for identification, especially those that had senesced early in the year. Despite these challenges, we are confident that with respect to the relevant CRAM metrics, dominant species were correctly categorized as native or non-native.

We also had to adapt CRAM guidelines for the timing and seasonality of assessments. CRAM was designed to be performed during the growing season, which for different wetland types in different locations might occur at different times of the year. However, the timing of this project required that our field evaluations be made during the summer and early fall of 2005, when many annual plants had already senesced for the season. To reduce the effect of this off-season sampling, we departed from the written CRAM methodology and included senesced annual plants in our cover estimates. Such individuals were identified to species where possible, any unidentified individuals were combined into larger unidentified categories according to our best judgment of native/non-native status, and cover estimates were made. Although we tried to identify all species that would have been included if the site had been assessed during the growing season, some herbaceous plants undoubtedly had decomposed or were unrecognizable at the time of our site evaluations.

Ambrose and Lee (2004) had modified the previous version of CRAM by superimposing a numerical scale over the CRAM letter grades and developing algorithms for combining metric scores into scores for each of the four attributes plus a Total-CRAM score for the entire file. For CRAM 3.0, the CRAM development team opted against the 1-12 scoring scale used by Ambrose and Lee (2004) and adopted a modified system of letter grading instead. This system allowed for the application of "+" and "–" designations to add refinement to the existing letter grades. For most metrics, which are scored on an A-D scale, this system is analogous to the 1-12 scale. However, a few of the CRAM metrics are limited to an A-C scale and one has been expanded to an A-E scale. The CRAM developers intend that these letter grades be combined into a single CRAM score, but a convention for doing so has not yet been developed. For our site evaluations, we followed the new protocol and scored the CRAM metrics as letter grades, adding + or – designations as appropriate. Once all CRAM data were finalized, entered and checked for quality control, we converted these letter grades to numerical scores for analysis. The majority of the metrics, which were on a D- through A+ range, were converted using a corresponding 1-12 scale. Metrics with a C- through A+ scale were converted using a 1-9 scale, and E- through A+ metrics were converted using a 1-15 scale. Details regarding our conversion conventions are provided in Appendix 7. To normalize these scores so they could be combined, the scores were converted to percentages (e.g., 9/12 = 75%) so that all metric scores would be on the consistent 0-100% scale.

CRAM scores were combined in three stages. First, a single score was determined for each metric. For mitigation sites with a single CRAM, no further adjustments were needed. For CRAM evaluations that were subsamples for a large or complex mitigation site, a mean metric score was calculated by averaging each of the separate metric scores. For example, if three depressional wetlands were randomly selected and assessed within a larger complex of depressions, then these would be averaged together at the metric level in order to arrive at a single set of CRAM scores for that mitigation site.

Next, the individual metric scores were combined by attribute (e.g., buffer/landscape context and hydrology) and then into a single CRAM score fore each mitigation site. For the hydrology and physical structure attributes, the metric scores were treated as equal and independent, so they were simply averaged. The buffer/landscape context and biotic structure metrics were more complicated and were treated differently. For biotic structure, the two plant community metrics (percent invasive plant species and native plant species richness) were clearly related to one another (high non-natives usually meant low natives). Therefore, before averaging with the rest of the biotic structure metrics, a geometric mean was calculated for these two scores. Within the landscape context category, the percent of the assessment area with buffer and the average width of buffer metrics jointly determined the general buffer extent, and these in combination with buffer condition, reflected the overall buffer quality. To clarify this point, it is possible to have a very high quality buffer that is adjacent to just a small portion of a site. Conversely, most of a site may have extensive buffer areas that are of very low quality. To account for the complex relationship among these three metrics, we first took the geometric mean of the percent of assessment area with buffer and the average width of buffer metrics to determine general buffer extent, then took the geometric mean of this result and buffer condition. Once we determined this overall buffer score, it was averaged with the remaining landscape context metric, connectivity, to determine the landscape context category score. The four attribute scores were averaged to obtain an overall Total-CRAM score.

Finally, a single CRAM score was calculated for each permit file. For files with a single mitigation site, the final CRAM score for the file was the same as the score for the site. For files with multiple mitigation sites, a final CRAM score was calculated using a weighted average of the scores for the individual mitigation sites. The individual CRAM scores were weighted by the area of the mitigation site. Weighting the CRAM scores by acreage prevented a small mitigation site from having a disproportionate effect on the score for the file. For example, if a file had a very small wetland creation site that received a high CRAM score and a very large wetland restoration site that received a marginal CRAM score, a simple average of these two CRAM scores would not reflect the combined wetland condition because of scale differences between the component sites. To account for this, we multiplied the individual CRAM scores by the proportional acreage of each mitigation site.

Determining the acreages for each mitigation site required a careful review of the permit files, which we accomplished after all sites had been assessed. There was no simple procedure for making the acreage determinations since the permit files are complex and each poses a unique set of circumstances concerning the component site acreages. In some cases these acreages were taken from our GPS data, sometimes they were obtained from the permit file paperwork, and sometimes both sources of information were used. As an example, suppose a file involved 1.0 acre of onsite riparian enhancement and a payment for 0.25 acres of vernal pool creation credits at a 10-acre mitigation bank. We might have used the GPS to delineate the boundaries of the riparian site and measured an area of 0.95 acres. We considered how confident we were in our GPS surveys before deciding whether to apply the expected or the measured acreage. If there was a very clear perimeter to the site and we had good satellite coverage, we would use the measured value; otherwise, we would use the expected value from the permit paperwork. For the mitigation bank, even if we had done a series of CRAM evaluations at the mitigation bank to represent the 10 acre site, and these were later combined for a single score for that site, we would still use only the 0.25 acres of credit for our acreage proportions because that was the fraction of the entire site that related to the permit file. Had we applied the expected riparian acreage from the permit file, then the total file acreage would be 1.25 acres, which would yield acreage proportions of 0.8 and 0.2 to be multiplied by the respective riparian and vernal pool CRAM scores. Using a similar procedure, we established the acreages associated with every mitigation site, which were then used to weight the CRAM scores for each mitigation site in order to calculate a single CRAM value for each permit file.

3.7.2. Reference Sites

As part of CRAM development, CRAM was to be calibrated through extensive sampling of a range of wetlands within each wetland class, including high quality reference sites. Without some calibration of wetlands in optimal condition, the appropriate target for judging mitigation sites was not clear. Performing CRAM at reference sites and viewing the resulting distribution of scores would help define the appropriate target range for mitigation success. To provide a sound foundation for evaluating mitigation sites in this study, we performed CRAM at a series of reference sites distributed throughout the state.

Before field sampling began, we carefully considered how reference wetlands would be used. It would have been useful to sample reference sites that were paired with impacts sites and could represent the condition of wetlands at impacted sites. Unfortunately, it was not possible to match impacted wetlands in this study. Instead, the reference sites are used to provide a context for the condition of the mitigation sites, rather than as a direct comparison to the condition of mitigation sites. We were aware of the problem of setting the bar very high for mitigation by choosing only pristine wetlands for our reference sites, and we explicitly did not search out the best possible wetland sites in the state as references. Instead we tried to identify reference sites of comparable condition to natural wetlands in the area**.** Our reference sites were relatively unimpacted by human activities compared to other wetlands in a region, but were not pristine. We generally avoided wetlands with distinct development (such as houses) in the watershed, but some reference sites certainly had been influenced by human activities. For example, in the southern Central Valley, there is essentially no portion of the lower valley floor that has not been modified in some way by human activities, yet this is where most of the permitted impacts occur and where most mitigation sites are located. These reference wetlands may be of slightly higher condition than wetland sites that were impacted, but that is not necessarily the case.

We needed to sample reference sites because CRAM had not yet been fully calibrated, so it was not clear what any particular value of CRAM meant compared to the condition of natural wetlands. The main use of the reference sites was to establish the cut-off between optimal and sub-optimal condition, which was set to include about 89% of the reference sites. This cut-off varied for the total CRAM score and the scores for each attribute and could not have been calculated with data from reference sites. Because our reference sites were **not** chosen to be the best available sites, these data do not necessarily represent optimally functioning wetlands; however, they do give an indication of ambient conditions of wetlands in the state. They also serve as a reasonable target for mitigation. In evaluating mitigation results we have been careful to identify that our comparisons are to reference wetlands and that the condition of these may be slightly different than the condition of wetlands that were impacted.

In general, we took an opportunistic approach to finding reference sites in the field, sampling reference sites that were close to mitigation sites as time allowed. Discussion with local agency staff, environmental consultants, or private citizens were helpful in identifying potential reference sites, but we also consulted maps or aerial photographs and conducted internet searches to identify wetland sites in preserves or other open space areas of limited human influence. The UCLA group sampled 22 reference sites throughout the state, including (see Collins et al. (2005) for definitions): 5 high gradient riverine, 11 low gradient riverine, 2 lacustrine, 2 vernal pool, 1 depressional, and 1 seep/spring wetland (Table 1). Three of these sites were in northern California, but most occurred in the southern half of the State. The USF group planned to sample a similar number of reference sites in the northern half of the State, but they were unable to do so because of time limitations. To provide data for reference sites in the northern half of the state, we used data from the CRAM calibration teams, who had completed much of their calibration field work by the end of the field season. Their calibration trials involved just two wetland classes: estuarine and riverine. The CRAM calibration evaluations were done for a wide range of wetland conditions, from high quality sites to lower quality sites. To select appropriate reference sites from this data set, we used the qualitative assessments of overall wetland condition made by the calibration teams to select sites that were relatively unimpacted by human activities. The CRAM calibration teams provided us with data for 7 estuarine sites and 18 riverine sites (Table 1), resulting in a total sample of 47 reference CRAM evaluations (Figure 2). All reference CRAM data were incorporated into our Access database, subjected to standard QA/QC procedures, and analyzed for comparison with our mitigation site data.

3.7.3. Wetland Ecological Assessment

In our previous mitigation study for SWRCB Region 4, Ambrose and Lee (2004) performed an alternative condition assessment methodology called the Wetland Ecological Assessment (WEA), developed by Breaux and Martindale (2003) to assess mitigation sites in Region 2. We performed a separate WEA assessment for every mitigation site evaluated in Region 4 to compare to the CRAM assessments. We found a strong correlation between the WEA scores and the corresponding CRAM scores, with WEA yielding slightly higher condition scores. In the present study, we decided not to repeat a WEA/CRAM comparison for the southern California sites, but the USF group performed WEA at their sites in northern California. The WEA evaluation is presented in Appendix 10.

3.8. Mitigation Habitats Analysis

Evaluating wetland condition at compensatory mitigation sites through CRAM provides some measure of mitigation success. However, taken alone, these assessments do not indicate whether the mitigation actions resulted in "no net loss" of wetland acreage and function. In order to understand "no net loss" of wetland functions, one would need to perform an assessment at the mitigation site before and after the mitigation actions were made to understand the true functional *gains*, and before/after evaluations of the impact site would be necessary to understand any functional *losses*. Indeed while some mitigation projects convert upland habitats to wetlands, most mitigation actions are undertaken at locations that already include some wetland acreage and exhibit some degree of wetland function. Clearly, before/after evaluations of wetland function are not possible in a study like this because the projects have already occurred.

In our previous study of mitigation success, Ambrose and Lee (2004) investigated this "no net loss" question by performing qualitative assessments of the beneficial wetland services gained through mitigation activities compared to what was lost through project impacts. We were unable to perform similar assessment in the present study. However, we were able to expand another aspect of the Ambrose and Lee (2004) study, the jurisdictional habitats evaluation, which allowed us to investigate "no net loss" with respect to acreage of individual types of wetland habitat.

3.8.1. Jurisdictional Habitat Assessment

While wetland delineations at proposed impact sites are a required step in the permit process, there is seldom a requirement that similar wetland delineations be performed at mitigation sites to ensure that adequate acreage of jurisdictional habitat is created, restored, or enhanced. (For a definition of these terms, see Section 6.3.4.) At each mitigation site we made a general assessment of the approximate proportions of jurisdictional and non-jurisdictional habitat types that would have been recorded had such wetland delineations been made. These general assessments were not intended to represent full legal wetland delineations at mitigations sites, which would have been much too time-consuming and were beyond the scope of this contract; rather, these assessments were meant to provide a rough estimate of the extent of different habitat types present. In these assessments, the first distinction we made was between the portion of the site that was within the ordinary high water mark of the water body, including adjacent wetlands (federal "waters"), and the remaining portion of the site. The non-"waters" area was apportioned into riparian habitats and upland habitats. The "waters of the U.S." area was apportioned into wetland habitats and non-wetland "waters." These jurisdictional habitat categories are listed in a hierarchical fashion in (Table 2).

Our wetland estimates did not conform to the three parameter test (hydrology, hydric soils, and hydrophytic vegetation) because we did not measure soil characteristics. For younger sites, we factored in the potential for future development of soils and plants, provided that the hydrology was appropriate. Therefore, our data likely represent a slight to moderate overestimate of jurisdictional wetland habitat, since some of these sites might not develop hydric soils. In most cases, the established site vegetation was used to delineate wetland perimeters. However, for sites with sparse vegetation, site topography and hydrological indicators aided our boundary determinations.

In both 401 and 404 permits, non-wetland "waters" are often, but inconsistently, described in more specific categorizations such as "streambed," "open water streambed," "unvegetated streambed" and "vegetated streambed" habitats, but are sometimes simply referred to by some other description such as "riparian waters." We followed this same approach in subdividing the non-wetland "waters" category, but in a hierarchical way that would enable grouping in an unambiguous way. Non-wetland "waters" categorized as "other" were almost exclusively those riparian "waters" habitats that were within the ordinary high water mark of the water body, but beyond the channel or adjacent wetlands. The clearest definition of "riparian" specifies those areas "…adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines" (NRC 2002). But in regular use, and in the permit files, there is substantial ambiguity in the application of "riparian," with reported impacts to "riparian waters" that may or may not include the channel itself. This ambiguity makes it difficult for us to compare our riparian "waters" category to those from the permit files.

3.8.2. Habitat Acreage Analysis

Many of the 401 permits that we analyzed were issued early in the regulatory process, before aspects of impact and mitigation planning were finalized. As we carried out the early phases of this project, we noticed that the impact acreage and mitigation requirements reflected in the 401 orders frequently did not agree with the impact, required, and obtained acreage that ultimately occurred through project implementation. This lack of agreement would be manifested in the SWRCB database as well, since those data are derived from the information in the 401 orders. To determine the extent of this difference between the 401 order and actual implementation, we conducted a formal comparison.

After all the fieldwork was completed, we performed another review of all "fully assessed" and "compliance only" files to extract the most accurate information available regarding acreage losses and gains. We considered all relevant information, including all regulatory permits, the mitigation plan, monitoring reports, correspondence reflecting planning adjustments, and the dates of all such documents. The final acreages for project impacts, permit requirements, and the "obtained" acreage values determined through our study were recorded. For the impact acreage data, permanent versus temporary impacts were distinguished. In addition, acreage data were further categorized into their respective jurisdictional habitat categories (see Table 2) to analyze the individual habitat types lost versus gained. As with the more general information mentioned above, the impact and required data were obtained through our acreage analysis permit review, and the values for each habitat type were classified as permanent or temporary impacts. The "obtained" acreage data for the site were either taken from the permit files or from our GPS surveys, depending upon which values were deemed the most accurate. As mentioned earlier, when the site perimeters were clear and unambiguous, the data from our GPS surveys would be used, but when the exact perimeter of the site could not be delineated, judgments were necessary to decide whether to accept the acreage value reported in the permit files. Once the appropriate mitigation site acreage value was determined, it was sub-divided into its component habitats multiplying it by the jurisdictional habitat proportion values from our jurisdictional habitat assessment. These data were further divided into created versus enhanced acreage to distinguish acreage *gains* from habitat enhancements. These steps provided us with a clear analysis of acreage losses and gains and facilitated a separate analysis comparing these data to the corresponding acreage data reported in 401 permits and in the SWRCB permit tracking database.

3.9. Digital Photographs

Digital photographs were taken at all of the mitigation sites. Our objective in taking these photos was to capture the essential features of the site at the time of our site visit. In many cases, only a few photos were necessary to accomplish this, while many photos were needed at other sites. It was difficult to cover some sites adequately because of the sheer size or complexity of the site. In addition to the general site photos, close up pictures of individual plants were taken for the purposes of subsequent identification, or for other reasons. The digital images were organized within computer folders labeled with the appropriate file identification number. All digital images are provided in Appendix 13 of this report, on DVD media.

3.10. Data Management and Analysis

All permit review, compliance, CRAM, and supplemental data were entered into a series of Microsoft Access databases developed for this project. The UCLA and USF groups maintained separate databases for their respective files, and these were later combined into a single version. The CRAM data were entered into a database obtained from the CRAM developers to ensure that the results of this study could feed back into the ongoing CRAM development process. As indicated earlier, CRAM version 3.0 was used, but with certain interim modifications implemented by the CRAM development team (unofficially termed version 3.5). Data extracted from queries of the Access databases were typically imported into Microsoft Excel for processing, graphed using SigmaPlot v.9.0, and statistical analyses performed in Systat v.11.

Most of the data analysis procedures have already been discussed in earlier portions of this Methods section. In general, the data in this report are organized and analyzed in two distinct ways: (1) by file, and (2) by individual mitigation site. As stated earlier, a number of permit files consisted of two or more discrete mitigation sites that could not appropriately be combined into a single evaluation. Thus, separate functional evaluations and habitat analyses were made for each of these sites to yield a total sample of 204 individual mitigation site evaluations for the 129 assessable permit files included in our study. Individual CRAM scores were combined into a single overall Total-CRAM score by factoring the proportional acreage of each respective mitigation site. The permit requirements transcended these individual mitigation actions, and thus, a single compliance evaluation was performed per file. Where necessary, the CRAM and "habitat" results are presented by mitigation site with a sample size of n=204. In other cases, such as comparisons between CRAM and compliance, they are given by file with a sample size of n=129. In other analyses, the compliance data from these 129 permit files are combined with the "compliance only" files (where no CRAM evaluation could be conducted but compliance could be assessed) resulting in a larger sample size of n=143.

3.11. Quality Assurance/Quality Control

The quality assurance and quality control (QA/QC) measures required for this project were uniquely complex. This was mainly due to the interface between our needs regarding scientific rigor and objectivity and the inherently non-scientific regulatory practices we are studying. While several previous studies have investigated wetland mitigation success, the geographic scope and multi-agency aspects of this study were without precedent, and much of our methodology had to be developed and adaptively managed as the project progressed. Timing limitations were a factor here since we had just a single field season to implement what was originally conceived as a three year study. Given the extensive decisions and interpretations that were required in this study, splitting the effort between the UCLA and USF research groups compounded the QA/QC challenges. For many ecological studies, the QA/QC procedures simply involve checking for mathematical and data entry mistakes by reviewing 10% or so of the data sheets and calculations. For this project, the QA/QC procedures spanned the entire effort, from the earliest aspects of our permit review to data analysis. Many of these procedures have already been discussed in the above portions of this Methods section, but several more specific aspects of our QA/QC are provided here.

Throughout the permit file selection process, we developed and refined a series of rules and conventions for determining which files to pursue and which to consider outside the scope of this mitigation study. After our list of prospective files was generated, we went back through the original source list to ensure consistency. After all files were reviewed and categorized, we made sure that our conventions for excluding files were consistent. Several files ended up being excluded because of an incorrect interpretation of the permit file paperwork.

The task of extracting the relevant mitigation compliance requirements from a permit file was exceedingly complex and difficult to standardize. While the permits usually follow a standard format, most permit conditions are not clearly delineated but are mentioned diffusely throughout the text of the permits, mitigation plans and other documents. Our rules and conventions for extracting these requirements evolved considerably throughout the course of the study. After the initial lists of conditions were developed and entered into the database, they were modified repeatedly as each permit file was subjected to subsequent reviews. In some cases, conditions that had been included were removed when we determined they were really procedural in nature or had to do with minimizing impacts during project implementation. In other cases, relevant conditions were added after they were missed in an earlier review, sometimes because they were in obscure portions of the file paperwork. Many permit conditions that were extracted verbatim were later divided when we determined they involved two or more distinct assessable conditions. The rules for scoring the permit conditions were also developed and refined throughout the course of this study and many site evaluations had been completed before the methods were finalized. Later in the project, after all data were collected, every condition of every file was reconsidered to ensure a consistent scoring approach.

Despite attempts in CRAM development to reduce decision-making in the field and to improve scientific defensibility, there remained instances where differences in interpretation could lead to differences in data collection. Our previous experience with CRAM (Ambrose and Lee 2004) helped reduce these interpretation and decision-making issues substantially, as did the early field trials with members of the CRAM development team. After all the CRAM data were collected, we went back through all of the data sheets for every file to ensure that we had followed a consistent approach in all the evaluations. Numerous changes were made through this process, most in relation to the vegetation data and for the physical and biotic patch types. The plant community data are particularly noteworthy, as many species identification and consolidation issues were resolved through this process. For example, it was mentioned earlier that grasses and senesced annual plants presented unique challenges in our CRAM assessments. Through our QA/QC of the CRAM data, we discovered that the UCLA and USF groups diverged in their approaches to these issues and in their level of taxonomic resolution. The UCLA group had taken a more general approach to grass identification and had not included senesced annual plants in their evaluation. To maintain consistency, they went back through their data sheets and used site photos and other information to increase their resolution regarding grasses and senesced annual plants. The current version of CRAM included a provision that + or - modifiers be added to each of the letter grades; however, no rules for this procedure had been developed. After all other CRAM issues were resolved, we revisited our scoring decisions for every metric of every file to ensure that these grade modifiers were applied consistently.

The outcome of the CRAM evaluation was profoundly influenced by the correct interpretation of the assessment area. As discussed earlier, the CRAM methodology was designed to assess complete wetland systems, and conventions had to be established regarding the application of CRAM for the evaluation of discrete mitigation sites. A considerable amount of time was spent ensuring that our project researchers understood these conventions. After the field season, the habitat acreage analysis forced us to go back through every file to carefully consider the actual acreage losses and gains that occurred through project implementation. One objective of this analysis was to assign a proportional acreage value to each CRAM evaluation within a particular file. During this procedure, numerous inconsistencies were discovered in the way our established CRAM conventions were applied. For example, a particular mitigation action might have involved restorative plantings on or above the stream banks, yet the channel itself was included in the assessment area. Alternatively, the CRAM evaluation for this project may have involved the correct mitigation site assessment area, but a second CRAM evaluation was done just for the channel. As we reconsidered these issues for every permit file, several changes were made, ranging from simple data adjustments to entire permit files being moved from the "fully assessed" category to the "compliance only" category or being excluded altogether.

Measures were also taken to ensure that the data for our habitats analysis were consistent throughout. Understanding how to apportion a particular mitigation site into its component habitat types required careful consideration of regulatory jurisdictions and wetland delineation. At least one member from each research group had received formal wetland delineation training. In order to ensure consistency in our evaluations, we had intensive internal discussions regarding the jurisdictional issues. Yet during the habitat acreage analysis that we performed after the field season, several inconsistencies were discovered in the jurisdictional habitat data. While some of these errors were related to the apportioning of individual habitat elements, most were caused by the same misinterpretations of assessment area that beset our CRAM evaluations. One consistent misinterpretation of particular relevance to this habitat assessment was the restricting of the assessment area to the *wetland* portion of the site. As a hypothetical example, if the permit requirements and mitigation planning documents indicated that a 1-acre wetland site would be created, then our assessments should include the mapped boundaries of that 1-acre creation site, even if only one half of that area was actually wetland. While the purpose of the jurisdictional habitat assessment was to address this specific issue, many sites had been erroneously delineated as 100% wetland, even though the entire 1-acre site had been mapped. As we went back through every file to review the CRAM assessment area issues, we also resolved these jurisdictional habitat inconsistencies and then carried out the remaining portions of the habitat acreage analyses.

After the field data collection phase was complete, the paper data sheets were scrutinized by the field team to ensure that all information was filled in correctly, consistently and legibly. Any calculated values (e.g., acreage or percentage calculations) were double-checked with a calculator, and then the data were entered. In order to reduce human error during data entry, the CRAM Access database was designed to only allow data entry in the appropriate format specific to that data table. For example, one electronic CRAM data form only allows the entry of letter grades A, B, C, D, etc. when entering data into this form. Each research group entered the data for their respective field evaluations.

Once all data were entered, all computer files were double-checked against the paper data sheets to ensure that no errors occurred. Initially, 10% of the files were randomly selected and all data from those files were reviewed for completeness and accuracy in data entry. Through this process, enough errors were detected to warrant checking 100% of the files. This involved checking the data in our Access database both visually and using queries to ensure that there were no duplicate entries, blanks, or improper values (e.g., data that were out of the allowed range), and that data were completely entered into all relevant tables. These QA/QC procedures extended beyond our Access database and included a thorough review of all data relating to our GPS surveys. The GPS data were treated separately from the remainder of the field data and were not included in the Access database. The QA/QC measures taken with respect to the GPS data include ensuring adequate satellite geometry, maintaining a PDOP value around 2.00, differentially correcting the data using the nearest base station provider, and keeping a record of all base stations used in the differential correction of all files. In the end, every datum from every field form was double-checked against the databases, and all mistakes discovered were corrected. We are confident that the resulting dataset is free from significant data management errors.

As mentioned above, ensuring consistency between the UCLA and USF research groups was challenging. Early in this project, both teams participated in a CRAM calibration meeting that involved field testing of the method to ensure user consistency. Then, to ensure that both groups were employing a consistent approach, a member of the USF team joined the UCLA group for the first round of mitigation site field visits, and the project coordinator from UCLA later joined the USF group for two separate weeks of field work at northern California sites. Extensive phone and email correspondence also helped in this regard. After the field season, both groups were responsible for the QA/QC of their respective permit files. Then, after the majority of the QA/QC procedures were completed, members of the UCLA group traveled to USF to help them finalize their remaining data tasks. During that visit, enough data errors and inconsistencies in approach were discovered to warrant a second round of QA/QC procedures between groups. Through this process, every USF file was subjected to a thorough re-review, which involved rechecking all aspects of the data for consistency, including the permit review, permit compliance, CRAM, habitat acreage analysis, and GPS data. Once all data modifications were complete, they were re-entered into the computer databases and all relevant files were checked one last time to make sure that every datum was correct.

4. Results

This section presents results for the four principal components of the study: (1) permit review, (2) permit compliance evaluation, (3) evaluation of wetland condition, and (4) habitat acreage analysis. A final section combines elements from the individual sections to provide a synthesis of some of the study's results.

4.1. Permit Review

As noted in the Methods section, we experienced numerous difficulties in selecting, identifying, and locating an adequate number of permit files distributed by region and year. The details of these complications are provided separately in Appendix 1.

Between 1991 and 2002, a total of 9,924 CWA Section 401 permit orders were generated by the 12 SWRCB regions and sub-regions. The greatest numbers of 401 permits were issued in Region 2 and sub-Region 5S, followed by Regions 4, 9, 3, 8, and 1 (Figure 1). Our initial goal was to assess at least 100 permit files across the state, apportioned by region according to the percentage of the total state 401 orders that each region had issued. The percentage values displayed in Figure 1 reflect the proportions of files issued within each region; these regional proportions were used to calculate the target number of files to be assessed by region, given our initial goal of 100 assessed files. In the end, we assessed 143 permit files (Table 3). Narrative descriptions of each assessed project are provided in Appendix 12. Of these, 129 were fully assessed for compliance, habitat acreage and condition, while 14 were assessed for compliance only (e.g., fees paid). In addition, we identified 13 permit files with either clear compliance shortcomings (i.e., impacts occurred but mitigation project was never undertaken), or expected shortcomings suggested by denials of site access. A list of these files has been provided to the State Board.

Of the 429 permit files randomly selected and pursued at either the Corps or Regional Board offices, a large percentage (40%) could not be positively identified in the agency databases or located in the file archives (Table 3). Many files that *were* located (104 files) were excluded after further review because they did not have assessable mitigation projects. We had difficulties finding assessable files in all regions, but particularly in Region 9, Region 7, and the two sub-regions of Region 6 (the reasons for this are discussed in Appendix 1). Files that were potentially assessable but were not assessed for lack of time are included in this table for completeness, as are two multi-regional files that had been issued directly by the State Board.[7]

Mitigation sites were more heavily concentrated in portions of the state with greater development pressure over the past 10-15 years (Figure 3), particularly the San Francisco Bay area, north of Los Angeles, Orange County, and San Diego. Several sites, especially those in the Central Valley (Region 5) involved a collection of shared mitigation banks, so there are fewer than 129 mitigation points on the map. Most regions had some "compliance only" files (Figure 4), with no particular pattern among regions except Region 4 having a somewhat larger number than the other regions. Surprisingly, the projects regulated by the various Regional Board offices (see regional tallies in Table 3) did not always fall within the boundaries of those regions. For example several of the 401 permits located in the southern portion of sub-Region 5R were issued by the Sacramento office (5S); two in the southern portion of sub-Region 5S were issued by the Fresno (5F) office and the San Francisco office (Region 2) permitted some of the projects within areas designated as Region 1. Alternatively, the perimeters of the regions and sub-regions, as indicated by the SWRCB GIS base maps, might not reflect their true jurisdictional boundaries. For the purposes of this study and our respective analyses, such permit files remained associated with the issuing regional office.

The 143 assessed permit files involved 204 distinct mitigation sites or actions (Table 4). Of these, 62% (127 sites) were within or immediately adjacent to the greater project boundaries (onsite), while the remaining 38% (77 sites) were offsite. There was no obvious geographic pattern to the offsite mitigation sites (Figure 5). While the majority of permit files involved permittee-responsible mitigation linked to specific permits files (hereafter termed file-specific mitigation), others involved third-party

[7] These two files were obtained inadvertently since multi-regional projects were not part of our file selection/regional apportioning methodology. Even though the files were potentially assessable, the files were excluded from our study because they were not selected in accordance with our selection protocol.

mitigation strategies such as mitigation banks or in-lieu fee payments, or informal, permittee-controlled mitigation banks which were used by those permittees for multiple permit actions. Some mitigation projects included both onsite file-specific mitigation and offsite payments for mitigation bank credits. In total, about 75% of the mitigation actions were file-specific, while the remaining 25% purchased or applied acreage credits at some larger restoration, creation, or preservation site. Of these latter actions, 30% involved the application of acreage credits within informal permittee-controlled mitigation banks. For the remaining 70%, a third-party approach was employed that included credit purchases at formal mitigation banks or in-lieu fee programs. Payments for acreage at formal mitigation banks recognized by the Corps and/or FWS made up the majority of these credit purchases, while three mitigation actions involved in-lieu fee payments to invasive species eradication programs. While several regions applied such strategies, the use of mitigation banks was especially prevalent in Region 5 (Figure 5). Of the 24 fully assessed files in Region 5S, 17 involved credit purchases at five mitigation banks. One of these mitigation banks was used by 13 files. Further details on mitigation bank projects are given in Appendix 9.

The files we assessed included both older and newer mitigation projects (Figure 6). The number of 401 orders issued by the SWRCB gradually increased from 1991 to 1998, declined through 2000, and then increased again through 2002. We had initially selected a roughly even distribution of files throughout the years, except for the early years prior to 1995 for which fewer 401 orders were issued. The distribution of assessed files roughly followed the distribution of certifications, but with disproportionately more 1996-1998 and 2000 files, and disproportionately fewer 1992 through 1995 and 2002 files. We did not assess any files with 401 orders issued in 1991, which is not unexpected given the low number of files available from that year. As is discussed in Appendix 1, we had a difficult time obtaining assessable files from the earlier years (1991-1994) due to the prevalence of unconditioned waivers issued during that period. For these 401 actions, the compensatory mitigation requirements of other regulatory agencies were often explicitly or implicitly invoked by the Regional Boards, but such requirements were not clearly indicated in the 401 certification orders, or in the SWRCB database. It is not clear why our sample included so many 1997 and 2000 permit files; for some unexplained reason, files from these years were more easily located and more frequently contained assessable mitigation projects. The reason that proportionally few 2002 files were included might be because many mitigation projects had not yet been undertaken.

Nearly half (46%) of the 143 files we assessed represented permits given to developers (Figure 7). Municipal permits comprised almost a quarter of the files (24%). The California Department of Transportation (Caltrans), industry, private, and state/federal agencies each comprised 6-9% of the total number of files. Caltrans was distinguished from other state and federal permittees because of the large number of permits they received and the uniformity in the types of projects involved (mostly bridge crossings).

In the following paragraphs we provide an analysis of assessed files by habitat type, impact type (permanent or temporary), and several aspects of the impact and required mitigation acreage. The data used in this analysis are not simple extractions of 401 permit information taken directly from the SWRCB database or the 401 permits. Instead, they were derived from detailed reviews of all project-related information found in the permit files, including the 401 permit, the 404 permit and other agency permits, all mitigation planning documentation, and post-construction monitoring reports. Taken together, this information provided us with the most complete picture possible of the "as built" impacts and mitigations that occurred under the 401 program. During our permit reviews we discovered that the information obtained in this way frequently differed from the corresponding information taken directly from the 401 permits or the SWRCB's permit tracking database. Through a specific analysis performed to understand the nature of these discrepancies, we found that the source of the differences ranged from simple data management issues to more substantive issues of potential regulatory concern. The results of that analysis are presented below, near the end this section.

Wetlands were the habitat type impacted by the most files (Figure 8), although there were substantial impacts to habitats classified as "riparian" and "streambed," as well as combinations of these three. A few files had impacts to non-streambed open "waters," such as, lake and ocean habitats. Some files reported impacts to a single habitat type while others impacted multiple habitat types. For several files, the impacts were not well specified. Some of these listed impacts to unspecified "waters of the U.S." while others did not provide any specificity for the impacts.

For the overall acreage impacted and required, data from the files were consolidated and displayed by logarithmic size categories as appropriate for the wide range of acreages involved (Figure 9). These figures show that most files involved impact and/or required acreage values in either the 0.1 to 1 acre range or in the 1-10 acre range. However, a substantial number of files had acreages in the 0.01 to 0.1 acre range and, overall, the acreages involved ranged from 0.002 to 60 acres. The total acreage impacted and required for these 143 projects, as determined by our detailed file review, were 216.8 and 445.2 acres, respectively. Permanent impacts, totaling 166 acres, far outweighed the 51 acres of temporary impacts (Figure 10).

In most years, more acres were required for mitigation than were allowed to be impacted (Figure 11). Ten percent of the projects (14) had fewer acres required for mitigation than were allowed to be impacted. The overall mitigation ratios were particularly large in 1996, 2000, and 2002. When the required mitigation ratios were calculated on an individual project basis and averaged by year, there also was no consistent temporal pattern in mitigation ratios through the years (Figure 12). The higher mean mitigation ratio in 1994, 2000, and 2002 were largely due to single files in each of these years with relatively large ratios (23:1, 70:1, and 123:1, respectively).

The Regions differed in the amount of impacts and mitigation included in the permits we reviewed. Among the well represented regions (those with greater numbers of file assessments), the combined acreages of impact were relatively high in Regions 2, 4, 5S and 8 (Figure 13). Among the well represented regions, Regions 2, 5S, and 8 required the highest cumulative mitigation acreage (summed across all project files); Region 7 also required a relatively large amount of cumulative mitigation acreage, though it was represented by few permits. Among these regions with relatively high cumulative mitigation acreage, Regions 2, 5S and 7 had relatively low cumulative acreage of impacts. In addition to cumulative acreage summed across all project files, we examined the average impact and mitigation acreage per file. The mean mitigation ratios required for these projects also varied across regions (Figure 14). Regions 2 and 4 had the highest mean ratios, but the large standard errors for these regions reflect a great deal of variability amongst projects in these regions.

The results for Region 7 (Figure 13) are notable in that the disproportionately high amount of impact and mitigation acreage occurred through just three permit files. This was primarily due to a large restoration project initiated by the United States Fish and Wildlife Service, wherein twenty acres of wetlands adjacent to the Colorado River were to be dredged to form a deepwater lake. The mitigation for this project was to include 40 acres restoration (invasive removal and riparian plantings around the lake), plus the lake conversion itself (20 acres). Although it was discussed in the 401 permit, the wetland acreage lost was not specified as impacts by the Regional Board and was thus not included in the SWRCB database. Even though there was no impact acreage listed, the permit (and database) included the 20-acre lake conversion as compensatory mitigation. The 40 acres of required restoration were not recorded as compensatory mitigation in the permit or database.

4.1.1. Discrepancies between file information and SWRCB database

As indicated above, we discovered numerous discrepancies between the information obtained through our detailed file reviews and the corresponding information found in the 401 permits and the SWRCB database. Two examples illustrate such discrepancies: (1) for approximately 25 files, the database indicated wetland or streambed impacts that either did not occur or occurred in combination with other habitat impacts that were not recorded in the database; (2) according to the database, the selected files involved a little over 2 acres of temporary impacts, while we determined that, in fact, there were over 50 acres temporarily impacted. In addition, there were approximately 34 fewer acres of permanent impacts than reflected in the database. Data entry errors at least partially influenced these results. In the SWRCB database, there are data entry fields for habitat impacts (e.g., “Wetland,” “Riparian,” etc.), and temporary impacts (e.g., “WTEMP,” RTEMP,” etc.). According to the written conventions of the SWRCB, the former data fields are to be analogous to “total impacts,” and the latter fields are supposed to include the subset of the total impacts that are temporary. In practice, the ambiguity that is inherent in these data entry labels has led to substantial inconsistency in data entry. While we did not do a file by file analysis of this issue, our file information reviews identified numerous examples where the permanent and temporary acreage data were entered separately such that the sum of these data fields would equal the total impact acreage.

There were considerable differences between the impact and required acreage values reflected in the database and the corresponding acreages that were ultimately involved. According to the SWRCB database the total acreage impacted and required for these 143 permit files was 198.9 and 241.0 acres respectively, while the corresponding values reported above were 216.8 and 445.2. Several files for which zero impacts were indicated did involve clear impacts. To understand how these differences varied among the files, we subtracted both impacted and required acreage values obtained through our detailed file review from the corresponding database values and plotted the resulting distributions (Figure 15). Of the 143 projects, approximately 48% (68 projects) had impact acreage differences between our file review and database. Twenty-one percent had fewer impacts indicated in the files than the database and 27% had greater impacts. The differences for most projects were below 1 acre, but the differences exceeded 1 acre for 10 projects. For required acreage, 63% (90 projects) had differences between the file review and database. For 53% percent of the projects (76 projects), information in the file indicated that more mitigation acreage was required than was indicated in the SWRCB database, while less acreage was required for 10% of the projects. For most of the projects, the discrepancy in acreage requirements was less than 1 acre. The discrepancies exceeded 1 acre for 31 projects.

In order to understand the nature and source of these variations, a comprehensive acreage discrepancy analysis was performed. Every file for which our reported impact and/or required mitigation acreage differed from the database values was thoroughly reviewed. Impact and mitigation acreage data were extracted from each document in the file, including the 401 permit, 404 permit, streambed alteration agreement, biological opinion, and mitigation plan, plus monitoring reports and correspondence. The relevant dates were noted and the text of each document was read, in detail, for context. Based on the review, the final impact and mitigation acreage values were confirmed (our reported values), and a brief narrative was written for each file to explain the source of the discrepancy. Then the files were categorized according to the type of discrepancy. Files commonly contained two or more discrepancy categories.

The complete results of this acreage discrepancy analysis, including narratives, are provided in Appendix 3. The main findings are summarized in Table 5. Among the 143 randomly selected 401 permit files, discrepancies between our reported values and the SWRCB database values occurred in 101 files (71%). For 9 files (6.2%), the discrepancies were due to simple rounding issues and were inconsequential. For 26 files (18.2%), the discrepancies were caused by data entry or interpretation errors when the 401 permit information was entered into the SWRCB database. Data interpretation errors were usually the result of unclear permit language and the lack of unambiguous acreage fields; other data entry errors included inputted values that were incorrect by a factor of 10 (e.g., 0.07 acres instead of 0.7 acres). While database entry issues are troublesome, it is the content of the 401 orders that the Regional Boards rely on for compliance considerations. In comparing our results to the information extracted directly from the 401 orders, discrepancies were still found for 60% of the files (86 files). For 19 files (13.4%), another regulatory agency simply required more mitigation acreage than the Regional Board, and we reported this greater acreage; these discrepancies are not errors, but simply reflect differences among agencies. These above categories amount to relatively minor quality assurance and quality control (QA/QC) issues.

For 27 files (18.9%), the discrepancy was due to an accounting difference. For example, the Regional Board may have only considered wetland or permanent impacts while the project included impacts to non-wetland “waters” and temporary impacts, respectively. For 24 files (16.8%), the information in the 401 orders contained transcription, typographical, or interpretation errors indicating impact or mitigation acreage values that were clearly different from the planning documents available prior to 401 issuance. Both of these categories reflect inconsistencies in the writing of 401 permits and indicate that under the 401 program, the SWRCB may not always be regulating the full suite of jurisdictional impacts that are occurring. The extent to which these inconsistencies are understood and intentional is not known.

Legally, it is the 401 permit, as written, that defines the requirements of the SWRCB and the permittee must comply with the terms of that permit. In practice, changes regularly occur following the issuance of the 401 permit, and we observed that the 401 permits did not always reflect the most current information regarding the project impacts and mitigation. Substantive changes in project planning or implementation that occurred after the 401 was issued resulted in discrepancies in 40 (30%) of the files. For 12 of these files (8.4% overall), the impacts were not altered but there were changes in the context or acreage of the mitigation project. For five of these files, another agency approved modifications that resulted in greater mitigation acreage, but for the other seven, the approved changes resulted in lower acreage or a fundamentally different mitigation strategy (e.g., offsite purchase vs. onsite creation; riparian enhancement vs. wetland creation). Reductions in the amount of mitigation required or substantive changes in the mitigation approach would seem of regulatory concern to the SWRCB. The other 28 files involved changes in impact acreage. For three of these files (2.1%), the project impacts were reduced after the 401 was issued but the mitigation stayed the same. For another 13 files (9.1%), lower impacts were accompanied by a change in mitigation required by other agencies. Of these latter files, most had lower mitigation acreage than required in the 401 permit as a result of decreased impacts. However, at least two files contained a fundamentally different mitigation strategy. If the mitigation acreage undertaken was lower than that specified in the 401 permit, then this could be of concern to the SWRCB, but if the lower mitigation was the result of impact avoidance understood and approved by other regulatory agencies, then such departures from the written 401 requirements might be judged less important. For the remaining 12 files (8.4%) out of the 28 files involving changes in impact acreage, changes during project planning or implementation resulted in greater impacts than reflected in the 401 permits and SWRCB database. An increase in the area of impact would seem of regulatory concern to the SWRCB.

In all cases where the 401 permit information did not reflect later impact and/or mitigation adjustments, the planning modifications were approved by another regulatory agency (i.e., Corps, Fish and Game, or Fish and Wildlife Service). For most projects, we could find no evidence that the Regional Board was consulted or copied on the modifications; while one or more of the other agencies were regularly addressed on correspondence, listed on the documents as responsible parties, or included in copy-to lists, the Regional Board seemed to be largely omitted from the decision-making process after the initial 401 review. Note that our review was often based on files from the Corps rather than Regional Board files, so we might not have seen some correspondence. However, the Regional Board should nonetheless have been named on copy-to lists and other documents. These examples indicate that communication between the Regional

Board and the permittees, consultants and other agency staffs involved in ongoing project planning and implementation occurring after 401 issuance could be improved.

Of the 40 files which had substantive changes after the 401 was issued, the Regional Board *was* copied on the changes for only a few. However, these notifications did not result in modified 401 orders. When modified 401 orders are created, they supersede the original order, and the SWRCB database is to be updated with the revised impact and mitigation acreage information (also, the term "CERTMOD" is to be included in the notes field). We have found that this database updating is regularly done correctly. However, through the acreage discrepancy analysis, we found that for 7 of the 143 randomly chosen permit files (5%, or 17.5% of the 40 files we reviewed that had changes after the initial 401 certification), the information from these revised certification orders (dates, acreages, etc.) was erroneously recorded redundantly in the database as separate records.

The sources of the acreage discrepancies we found fall into three broad categories: (1) data management and QA/QC issues; (2) inconsistencies in the writing of 401 permits; and (3) deficiencies in communication and follow-up after 401 issuance. Discrepancies falling into the first group, while notable, do not raise substantive regulatory/compliance concerns, while those from the other groupings may or may not raise regulatory concerns. To understand the extent of the regulatory/compliance issues indicated by the discrepancies, we performed a specific analysis considering the context and nature of the discrepancies for every file, judging whether they represented a substantive regulatory/compliance concern for the RWQCB/SWRCB. If the source of the discrepancy was limited to (1) a minor rounding error, (2) a database entry error, (3) another agency requiring greater mitigation acreage, or (4) reduced impacts with either no change in mitigation acreage or increased mitigation, then the discrepancy was not deemed a regulatory/compliance concern. However, if the source of the discrepancy fell within any of the other categories of Table 5, then the project was deemed of regulatory/compliance concern. The guiding principle that we employed here was whether the 401 order would have differed if the 401 manager had (1) seen, correctly interpreted, and correctly transcribed all the impact and mitigation information we found through our file review, and (2) employed an approach consistent to that of other managers regarding the accounting of temporary versus permanent impacts and wetland versus non-wetland "waters" impacts. Through this analysis, we judged that there *was* a regulatory issue for 60 files (42%). While some of these files involved transcription, interpretation, or accounting issues involving information available prior to 401 issuance, the discrepancies for 38 files were caused by 401 permits that did not reflect planning and/or implementation changes that occurred after 401 issuance. This highlights an important fact: because the Corps requires proof of 401 certification (or waiver) prior to issuing the 404 permit, permittees seek their 401 certification early in the regulatory process before some avoidance and minimization of wetland impacts occurred and before the mitigation planning is finalized. In such cases, communication and follow-up between the Regional Board and permittees, consultants and other agency staffs is essential if the project changes, and our results indicate that it often was insufficient. When the 401 order is issued based on preliminary planning information, the order (and the corresponding database information) could become outdated unless the Regional

Board maintains an active role in the remaining aspects of regulatory planning and modifies the 401 certification if necessary. Our definition of "regulatory/compliance concern" assumes that the SWRCB would wish to regulate and track all wetland and riparian impacts (permanent and temporary) that occur within its jurisdiction. The permit files we documented with impacts exceeding those approved by the 401 permit would surely be of concern to the SWRCB; some of the other cases may be less important because, ultimately, it is the text of the 401 permit that the permittee must comply with in order to remain in compliance with the terms of the permit.

4.2. Status of Regulatory Compliance of Compensatory Mitigation Sites

Thirteen of the 257 permits we located had to be excluded because of potential compliance issues. This indicates that up to 5% of the files we reviewed may have significant compliance problems (such as the impact occurring but no mitigation being undertaken).

For the files we were able to evaluate, the majority met most of their permit requirements (Figure 16), although fewer met all conditions to 100% satisfaction. Of the 143 assessed permit files, 19 did not have any assessable 401 conditions (the 401 permit could not be located for 13 of these, although enough information was available from the Corps to locate and assess the site; whether these would have had assessable conditions is not known). For the remaining 124 files, the average 401 compliance score was 84% (Table 6). As described in detail in the methods, the average 401 compliance score (hereafter, average 401 score) was calculated as the mean of the compliance scores for all of the permit conditions; the potential scores for each of these conditions ranged from 0 to 100%. Almost half (46%) of the files achieved perfect (100%) average 401 scores, indicating that they were in full compliance with all 401conditions; 57% had an overall score of 90% or greater, and 77% had average 401 scores of 75% or more. Three files received average 401 scores of zero.

Compliance was also assessed by determining the percentage of permit conditions that were met completely (100% score) for a particular file (hereafter, average 401 percent-met score). This approach to measuring compliance is more consistent with regulatory evaluations, even though it is a more stringent standard, with no credit for partially meeting permit conditions. According to this approach, on average 73% of a file's 401 permit conditions were fully complied with (Table 6). Forty-eight percent of the files fully met more than 90% of their conditions, and 57% completely complied with at least 75% of their conditions (Figure 16). Seven files did not meet any of their conditions to 100% satisfaction.

Characterizing these files in terms of success or failure for compliance is not straightforward. For some files, the 401 requirements may have involved a single mitigation condition, such as an acreage requirement. Other files might have multiple conditions, including highly specific planting requirements and performance standards if the 401 permit had included a condition to follow the mitigation plan. There is no simple prescription for determining which aspects of the mitigation plan to include as assessable conditions; these documents are not organized in a way that makes this tractable. The "conditions" extracted from these plans were often difficult to assess. Moreover, the complexity of some conditions meant that 100% compliance might not be realistic. Nonetheless, we did use the 100% criterion as the standard against which files should be judged and concluded files were in full compliance only if all conditions were completely met. We placed near-misses in the 75% (mostly met) scoring category; therefore, we defined the lower limit of this category as the cutoff for "success." Likewise the cutoff for "failure" was defined by the upper limit of our 25% (mostly not met) scoring category. Given this convention, 76% of the permit files were considered successful according to the average 401 score and 4% were considered failures (Table 6). The remaining 20% were partially successful. According to the average 401 percent-met score, 57% were successful, 30% were partially successful, and 13% were failures. Although a simple success/failure evaluation is not as informative as the numeric evaluations given in the previous paragraphs, we made success determinations to facilitate a simple summary of the compliance results.

Although compliance with mitigation plans was included in the 401 compliance assessment if the mitigation plan was invoked (directly or indirectly) by the 401 permit, we also conducted a separate compliance evaluation for mitigation plans, since they can be viewed as a proxy for all agency requirements for file-specific mitigation projects. The majority of projects (57%, or 81 of the 143 permit files) contained mitigation plans. Mitigation plans were not included in the remaining files for a variety of reasons. For some files, plans were not required (e.g., mitigation bank credits purchased); for others, the plan was not in the agency's file, presumably because it was misplaced or never submitted. Of the mitigation plans that were reviewed, some were relatively simple documents that described the general mitigation strategies; 16% of the 81 files had fewer than five conditions. The majority (84%) of the mitigation plans were detailed documents containing implementation plans and mitigation goals from which we extracted more than five conditions. The mitigation plan conditions for most (63%) files (44 of the 70 files for which we had conditions from both 401 permits and mitigations plans) had been invoked by the 401 permit and were included in the above 401 compliance evaluation. The mitigation plan conditions for the remaining 37 files are unique to this analysis.

The average mitigation plan scores for these 81 files was 81% (Table 6, Figure 17) compared to 84% for the 401 compliance scores for the total sample of 124 files (Figure 16). However, only 16% of the files had perfect scores (all conditions 100% met) and only 22% had scores of 90% or higher for the mitigation plans compared to 46% perfect scores and 42% with scores of 90% or greater for the 401 permits. Of the 81 files with mitigation plans, 68% were considered successful for mitigation plan compliance based on their compliance scores, 32% were partially successful, and none were considered failures (Table 6). Using the percent-met scores, on average 68% of a file's mitigation plan requirements were fully complied with. Forty-eight percent of the files were successful based on their percent-met scores, 35% were partially successful, and 6% were failures (Table 6).

Files scored significantly lower for mitigation plan compliance than for 401 compliance both for the average scores (Kolmogorov-Smirnov 2 sample test, $p<0.001$) and for average percent-met scores ($p<0.001$). It would seem that mitigation plan conditions are more difficult to fully comply with than 401 permit conditions. However, this conclusion could be due to the large percentage of the 401 permits with just one or two permit conditions (e.g., acreage requirements or credit purchases) with which compliance was relatively easy, whereas mitigation plans typically have many more conditions that the 401 permits. Seventy of the files for which we had mitigation plan scores also had 401 scores, so we could compare scores directly. The average mitigation plan scores for these 70 files were significantly lower than the average 401 scores (Wilcoxon signed-rank test, p=0.030), but the average percent-met scores were not significantly different (p=0.252). Thus, there is some evidence that compliance with mitigation plan conditions was lower than compliance with 401 conditions, but it appears that projects were as likely to comply fully with their mitigation plans as with their 401 permits.

For the 124 files evaluated for 401 compliance, on average 30% of the permit conditions were not determinable (Figure 18). All permit conditions could be determined for 40 files (32%). Eighty-four files had at least some conditions that could not be determined, with an average of 45% non-determinable conditions per file. When mitigation plan compliance was considered separately, 30% of mitigation plan conditions were non-determinable (similar to the 401 compliance result). All conditions could be assessed for only 12 out of 81 (15%) files (Figure 19). Sixty-nine files had at least some mitigation plan conditions that could not be determined, with an average of 35% non-determinable conditions per file. The results from these two figures are indicative of the differences between the types of conditions listed in the 401 orders versus typical mitigation plan conditions. Aside from invocation conditions (those requiring that the mitigation plan or other agency permits be followed), the mitigation conditions specified in the 401 permit often consist of a single acreage requirement. Those containing more mitigation conditions often include a range of other requirements that, like acreage, tend to be addressed in a yes/no fashion or are not determinable (e.g., revegetation requirements, and monitoring and submission requirements). Mitigation plans include many more specific “conditions,” such as requirements for site preparation, implementation, and performance standards. While such conditions are less frequently complied with at the level of 100% satisfaction, they are also more frequently assessable in an after-the-fact assessment, such as the present study.

One might expect compliance with 401 permit conditions to have increased through the years as the regulatory practices evolved; however, we did not find this to be the case (Figure 20; r^2=0.000, p=0.845). There was no significant difference in 401 permit compliance by year (ANOVA, p=0.959). Mitigation plan compliance was more variable through the years (Figure 21), and the correlation between compliance and year also was not significant (r^2=0.030, p=0.119). As with 401 permit compliance, there was no significant difference by year (ANOVA, p=0.357). Nor was there a significant difference between the early files (1992-1997) and the more recent files (1998-2002) in 401 compliance (Mean±SE= 84.9±2.9 for 92-97 and 84.0±2.7 for 98-02; t=0.223, P=0.824) or mitigation plan compliance (78.6±2.9 for 92-97 and 82.4±2.7 for 98-02; t= -0.944, P=0.348).

Overall, there was no significant difference in 401 compliance among regions (Figure 22; ANOVA, p=0.882). Similarly, there were no significant differences among regions for mitigation plan compliance (Figure 23; ANOVA, p=0.198).

Average 401 permit compliance did not differ significantly by 401 certification type (Figure 24; ANOVA, p=0.159). Section 401 orders fell into four general categories: certifications, certifications with conditions, waivers, and conditional waivers. Regulatory practice evolved over the study period, and after June 24, 2000, issuance of waivers was no longer authorized by the State Board. Some of the regulatory orders also comprised waste discharge requirements (WDRs), either standard WDRs, conditional WDRs, WDR waivers, or conditional WDR waivers. We treated these as equivalent to the corresponding 401 certification categories and grouped them accordingly. In terms of a Regional Board's level of involvement in the mitigation planning, one would expect certifications to include more involvement than waivers, and conditional orders more than standard orders. In practice, we found that the number of conditions from the various order types varied widely. From this study, it is unclear which certification category represents greater involvement by Regional Board staff.

There were notable differences in the frequency of use of the various categories of permit conditions (Table 7). In general, the majority of mitigation requirements dictated the actual tasks to be completed during the preparation and construction of the mitigation site (i.e., site implementation tasks). For 401 compliance, site implementation tasks comprised the most conditions (30%), followed by monitoring & submission requirements (19%), success & performance standards (15%), and acreage requirements (12%). While acreage requirements comprised 12% of the conditions, only one or two such conditions were necessary for any particular file. Of the 143 permit files, 89 (61%) included at least one acreage requirement. For other condition categories, a given permit file may have had 10 or more conditions per category, especially when the mitigation plan was invoked by the 401 order. Fifty percent of the 401 orders invoked the requirements of other regulatory agencies or required that the mitigation plan be followed. Conditions involving mitigation site maintenance and the protection of the site from degrading influences, plus third party requirements (mostly credit purchases), made up a relatively low percentage of the conditions. For mitigation plan compliance, most of the "conditions" involved site implementation (39%), success & performance standards (21%), monitoring & submission requirements (16%), and acreage requirements (9%). Excluding the miscellaneous "other" category, the average number of conditions per category ranged from 1.5 to 6.0 for 401 compliance, and 1.6 to 7.9 for mitigation plan compliance (Table 7).

Compliance across the condition categories was variable. Third party requirements were almost always complied with fully (Figure 25). Monitoring and submission requirements had considerably lower compliance (about 60%), although this could be due to the fact that some monitoring documents were submitted but were not located in our review. The other categories had compliance scores of 75-85%. Except for third-party requirements, the percent-met scores were considerably lower than the 401 scores. Acreage and credit purchasing conditions could usually be determined, while the conditions for other categories more frequently could not. Relatively few of the conditions in the success and performance standards category were non-determinable. Monitoring and submission requirements were more frequently non-determinable than other conditions, which is interesting since this category also had the lowest compliance scores when we could assess it. The patterns of compliance and non-determinability were similar for compliance with mitigation plan, although for mitigation plans, there was somewhat less variability among the categories (Figure 26).

Because many of the permit, and even mitigation plan, conditions include purely administrative requirements (such as submitting reports) or actions that are only peripherally connected to the ecological functioning of a mitigation site, we analyzed compliance for a combination of condition categories deemed most relevant to the success of the actual mitigation project. These categories, shown in the last line of Table 7, include the Site Implementation, Maintenance, Protection, and Success/Performance Standards categories. For this grouped category, the mean compliance scores were about 80% for both 401 and mitigation plan compliance. The mean percent-met score was considerably lower, 63% for 401 compliance and 66% for mitigation plan compliance.

All of the above 401 compliance results included the conditions found in mitigation plans and other agency permits that had been explicitly or implicitly invoked as a requirement of the 401 permit. In order to understand the contributions of the Regional Boards *per se* to the outcome of mitigation projects, we considered only those conditions specifically required by the 401 permits. A single mitigation-related permit condition was required for 27% of 401 permits (Figure 27). Another 18% percent of the permits contained two mitigation conditions, and 15% had three conditions. Ten permits (8%) specified 7-12 conditions, while eleven permits (8%) did not contain any mitigation-related permit conditions. These data do not include the eleven permit files for which no 401 permit was obtained. Among the 12 Regional Boards, Regions 6T and 6V required the most mitigation requirements per 401 order (Figure 28), but there were just two permits for each of these sub-regions. Of the regions with larger sample sizes, Regions 2 and 4 included relatively more mitigation conditions per file while Regions 5S and 8 included relatively few.

Of the mitigation conditions included in 401 permits, the majority involved acreage and third party acreage credit requirements, site maintenance requirements, and monitoring and submission requirements (Figure 29). Relatively few conditions specified the actual mitigation tasks to be implemented, protective measures, or success and performance standards. These data represent the conditions found in all 132 permit orders combined. When mitigation conditions from a given category were included in the permit order, there was, on average, between one and two conditions of that category per order (Figure 30). When present, there were close to two site maintenance and two monitoring and submission conditions on average per order, close to 1 site maintenance condition per file, and for acreage requirements, third party acreage credit requirements, and success and performance standards, there were approximately 1.5 conditions each per order.

As indicated above, most 401 permit orders included 1 to 3 mitigation-related conditions. When just a single mitigation-related condition was included, it involved a simple acreage or acreage credit requirement almost 90 percent of the time (Figure 31;

black and red bars, combined). Three single-condition orders contained site maintenance requirements and one contained a monitoring and submission requirement. Similar breakdowns are provided in Figure 31, for 401 orders with up to four mitigation-related permit conditions. As the number of conditions increased, the proportion of maintenance and monitoring/submission conditions increased. Site protection, site implementation, and success and performance requirements were always a minor proportion of the conditions. These data demonstrate that most 401 permit orders included in this study contained relatively few permit conditions dictating the actions to be taken at the mitigation sites, or the success criteria upon which those sites would be judged. Instead, most permits specified the mitigation acreage requirements, included some site maintenance requirements, and mandated that mitigation and monitoring related documents be submitted.

As we reviewed the files, extracted the relevant permit conditions, and consolidated the various agency conditions for our compliance analyses, we noted substantial overlap between the 401 conditions and the conditions required by other regulatory agencies. We performed a separate analysis to understand the extent of these redundancies. The conditions extracted from each relevant agency's permit were aligned with those extracted from the 401 permit orders. Each 401 condition was scrutinized for equivalency with the other permit conditions. Some were verbatim copies of other agency conditions, while others were different in verbiage but equivalent in context. In all cases, our test was whether the greater mitigation responsibilities would have differed had a particular condition not been included in the 401 order. Overall, 62% of 401 conditions were either redundant or invoking (Figure 32). Thirty-eight percent of the 401 conditions were unique to the 401 permit. Those conditions unique to the 401 permit included all 401 conditions involving monitoring and submission requirements, which were 25% all 401 conditions. Excluding these since other agencies had their own submission requirements as well, about 13% of all 401 conditions were unique requirements of the 401 program. A breakdown of redundant and invoked conditions by region is given in Figure 33. Regions 6T, 6V, and 7 had the lowest percentage of redundant and invoked conditions, but these regions had very small sample sizes. Among the other regions with larger sample sizes, Region 2 included a relatively greater percentage of unique conditions in their 401 orders. Region 8 was unique among these latter files as having a relatively low percentage of invoking conditions.

Considering the full set of conditions explicitly specified in the 401 orders, the mean permit compliance score was 84% (Figure 34). This score is identical to the overall mean compliance score given earlier (including invoked conditions from other permits). In addition, the distribution of scores is essentially the same as the earlier distribution. Because of these similarities, no further analyses were performed on these 401-specific conditions.

4.3. Function and Condition of Compensatory Mitigation Sites

CRAM evaluations were completed for 129 of the 143 permit files (14 files included in the above compliance evaluations did not contain assessable mitigation projects). These 129 files had 204 discrete mitigation sites due to multiple mitigation actions (e.g., depressional wetland creation plus riparian enhancement) that needed to be evaluated separately (Figure 3). Fifty three of these mitigation sites were sub-sampled because they were too large or complex for a single CRAM evaluation. These resulted in a total of 321 separate CRAM evaluations for this study. In addition, we performed CRAM evaluations for 22 reference sites across the State and added 25 more reference sites from the CRAM development team for a total of 47 reference site evaluations (Figure 2). CRAM results are presented below in two ways: one is by mitigation site with a sample size of 204, and the other is by file with a sample size of 129; for the latter, the scores of multiple mitigation sites were combined into a single overall score per permit file. Additional CRAM results that were too detailed for inclusion in the main report are provided in Appendix 7.

The 204 mitigation sites were largely represented by low gradient riverine (46%) and depressional (36%) wetland classes (Figure 35). The remaining 18% of assessed mitigation sites, in decreasing order of occurrence, were vernal pool, estuarine, lacustrine, seep and spring, high gradient riverine, and lagoon wetland classes. Although mitigation sites were distributed throughout the state, the occurrences of each wetland class vary by region (Figure 36), with vernal pool and seep and spring mitigation sites only present in central to northern portions of the State. Similarly, estuarine sites were primarily in the north, though two estuarine sites were located on the south coast of California. While depressional and low gradient riverine sites were common throughout the state, depressional sites were more prevalent in the north, and low gradient riverine sites dominated in the South.

4.3.1. Total-CRAM Scores

The total-CRAM scores for the 129 permit files assessed had a mean±SE of 59%±1.1, with a median of 61% (Figure 37; Table 8). Very few mitigation sites scored above 80%, while nearly 30% of the mitigation sites scored below 50%.

As mentioned previously, we collected data for 47 reference sites in order to put the mitigation CRAM scores in context. The total CRAM scores for the reference sites had a mean±SE of 79%±1.4, with a median of 82%. We used the distribution of reference site CRAM scores to establish categories of wetland condition. Nearly 90% of the reference sites had total CRAM scores of 70% or greater. For this reason, we established a 70% score as the cutoff for “optimal” wetland condition. We evenly distributed the remaining attainable CRAM scores into the three remaining categories. Thus, we defined the “sub-optimal” cutoff at 49%, and distinguished “marginal” from “poor” categories at 28%; in most cases, we have combined these categories and refer to them collectively as “marginal to poor.”

Using these criteria, *only 19% of the mitigation files were optimal*, just over half were sub-optimal, and approximately one-quarter were marginal to poor (Table 8). Files with optimal and sub-optimal scores were distributed throughout the state, though there was a prevalence of marginal to poor files in northern California around the greater Bay Area (Figure 38) [see Appendix 5 for detailed mapping of mitigation and impact locations by region]. In our previous study of mitigation success in SWRCB Region 4, we found that just 2% of the files assessed had optimal wetland condition (Ambrose and Lee 2004). However, in that study, optimal condition was defined as an 80% or above

CRAM score. We established that criterion based on the quartiles of the 1-12 scoring scale, since reference site evaluations were not available for that study. The reference site evaluations included here suggest that the 80% criterion used in that study may have been too high; more of the permit files included in that study would have been considered optimal had a standard of 70% been applied.

There was no relationship between CRAM score and certification year (Figure 39; r^2=0.005, p=0.415). Given evolving regulatory practices, one might expect more recent permit files to have mitigation sites with higher CRAM scores if more recent regulatory practices resulted in more successful mitigation projects. Alternatively, older sites have had more time to develop, so higher scores might be expected of these sites. Neither of these expected trends can be discerned for the actual relationship, with one possible exception. The CRAM scores for 2002 do not range as high as earlier years, which could be because these younger sites did not have enough time to develop sufficiently to score highly on CRAM.

There were significant differences in Total-CRAM scores by region (ANOVA: $F = 2.642$; $p = 0.005$) with relatively low median scores in Regions 1, 2, and 6V, and relatively high scores in Regions 8, 9, and sub-Regions 5F, 5S, and 6T (Figure 40; Table 9). Sub-Regions 6T and 6V had the highest (74%) and lowest (43%) median scores, respectively; however, these sub-regions had only two permit files each. When combined, the overall Region 6 score was comparable to the other regions (64%). A Tukey post hoc analysis revealed the differences between the low scores in Region 2 and the relatively high scores in sub-Region 5S ($p = 0.006$) to be responsible for the overall differences among regions. Region 2 had the highest percentage of marginal to poor files (52%), while Region 9 and sub-Region 6T had the highest percentage of optimal files (sub-Region 6T had only two permit files, both of which had optimal condition) (Figure 41). Neither Region 7 nor sub-Region 6V had any optimal files, but they had very few files. Sub-Region 5R did not have any marginal to poor files, and the percentage for sub-Region 5S was low, even with a large number of files. However, the majority of files for these sub-regions had sub-optimal rather than optimal condition. The results for sub-Region 5S are notable due to the high percentage of those files that used formal mitigation banks. The standard error of scores from this sub-Region was low (Table 9) and this likely influenced the significance region effect. However, 17 of the 24 fully assessed permit files from this sub-region used 5 mitigation banks (13 files used a single bank; see Figure 5), and so the CRAM scores of those banks were repeated across these files.[8] A more in-depth analysis and discussion of mitigation banks is provided in Appendix 9.

4.3.2. CRAM Attribute Scores

As with the Total CRAM score, we used the reference site data to provide context for the scores from the mitigation sites. We determined “optimal” cutoffs for each of the four CRAM attributes with the same criterion used to establish the overall “optimal”

[8] Rather than report the score for a particular mitigation bank site just once, the score was assigned to all files that purchased credits from that bank since the functional losses from those projects were to be offset by mitigation bank site function.

cutoff. Because the overall "optimal" cutoff contained 89% of reference sites above that score, we set each of the four attribute "optimal" cutoffs to the score with approximately 89 percent of reference sites above that score. For each attribute, we established the three remaining categories by evenly dividing the remaining attainable CRAM scores by three. Thus, for buffer and landscape context we established an "optimal" cutoff at 74%, "sub-optimal" at 52% and distinguished "marginal" to "poor" at 30%. We established a hydrology "optimal" cutoff at 76%, "sub-optimal" at 53% and distinguished "marginal" to "poor" at 30%. Physical and biotic structure attribute cutoffs were markedly lower than the overall CRAM cutoffs. Physical structure had an "optimal" cutoff at 53%, "sub-optimal" at 38% and distinguished "marginal" to "poor" at 23%, while biotic structure had an "optimal" cutoff at 47%, "sub-optimal" at 34% and distinguished "marginal" to "poor" at 21%.

4.3.2.1. Buffer and Landscape Context

The median landscape context score for the 129 files was 72% (mean 66%) with a distribution that was skewed towards higher scores (Figure 42, Table 8). Approximately half the files had optimal scores, while roughly a quarter of files each were in the sub-optimal and marginal to poor categories. Region 7 and sub-regions 5S and 6T scored particularly well in the landscape context attribute while files for Region 1 and sub-Region 6V scored lower (Table 10). Overall, five of the regions had the majority of their files with optimal scores, and four regions (Region 7 and sub-Regions 5R, 5S, and 6T) did not have any files scoring in the marginal to poor category for landscape context. Despite criticism that mitigation projects are too often placed in proximity to development, these results indicate that the mitigation projects we assessed have been undertaken at sites that were reasonably well positioned in a landscape context.

4.3.2.2. Hydrology

Hydrology attribute scores for the mitigation sites had a mean and median score of 63% (Figure 43, Table 8). Many (43%) permit files had sub-optimal scores, while 27% had optimal, and 30% had marginal to poor scores. The Total-CRAM scores for sub-Regions 6T and 6V were reflected in their hydrology scores with the highest (81%) and lowest (36%) scores of all regions (Table 11), but these two regions had only two files each so these extreme values are likely a consequence of the small sample size. Two sub-regions of Region 5 (5F and 5R) also had higher scores, but when these were combined with large number of files from sub-Region 5S, the overall Region 5 hydrology mean was similar to other files. Regions 3 and 4 had the lowest hydrology scores, as Region 3 had the majority of files being sub-optimal and no optimal files, while 80% of Region 4 files were evenly split between sub-optimal and marginal to poor for hydrology.

Improper hydrology has often been cited as the major shortcoming of mitigation project design (NRC 2001). The mitigation sites sampled during this project had lower hydrology scores than the reference sites, yet when compared to other CRAM attributes the site hydrology scores were not disproportionately poor. However, approximately 50% of the assessed mitigation projects were classified and evaluated as riverine wetlands, and our conventions for employing CRAM were quite liberal with respect to stream-associated mitigation. Many of the riverine/riparian projects we evaluated did not include the channel itself. Instead, they occurred along the sloping banks of stream channels, frequently extending some distance away from the top of the banks. Others began at the top of the banks and extended outward from there, with even less connection to the channel. If the site was in direct proximity and seemingly hydrologically "connected" to the stream channel, the channel-dependent aspects of CRAM were scored as if the channel was part of the assessment area. Hence, many riverine sites that largely lacked wetland hydrology on the site were given more favorable scores for hydrology than the restoration site alone would have warranted. If we had taken a more narrow scope in defining the CRAM assessment area, hydrology scores would have been much lower. This is an important point regarding the utility of CRAM in evaluating mitigation sites, and it will be necessary to establish a standard approach for identifying assessment areas for future riverine mitigation reviews.

4.3.2.3. Physical and Biotic Structure

The reference sites scored relatively low for physical and biotic structure and had wide variability in their scores (Figure 44 and Figure 45). Low scores at the reference sites are likely a result of CRAM calibration (more recent versions of CRAM have rectified this issue); however, since our classification of individual mitigation sites was based on their score *relative* to reference scores, this issue does not affect our evaluation . For reference sites, the median physical structure score was 79% (mean 76%) and the median biotic structure score was 68% (mean 67%). The overall low physical structure scores were mainly driven by low scores in the physical patch richness metric, while vertical biotic structure and biotic patch richness scores lowered the overall biotic structure attribute.

CRAM scores for mitigation sites were low scores for both the physical structure and biotic structure attributes, with mean and median scores just above 50% (Table 8). However, since the reference sites also had low scores for these attributes, the cut-off for optimal/sub-optimal was low. Most mitigation files scored optimally in physical structure, with approximately a quarter of files in the sub-optimal and marginal to poor categories. The majority of files were optimal for biotic structure, about one quarter were sub-optimal, and only 12% were marginal to poor. As with hydrology, certain aspects of the physical and biotic structure attributes were channel-dependent. That is, the metrics were designed around physical and biological aspects of the stream channel. In cases where a hydrological link between mitigation site and channel existed, the channel was treated as part of the assessment area for those metrics, even if the mitigation project did not enhance the channel area.

Region 2 had the lowest median score for physical structure (40%), with 48% of its files considered marginal to poor (Table 12). Similarly, only 25% of sub-Region 5F files were optimal, while neither of the Region 7 files was optimal. In contrast, Region 8 had the highest mean score for physical structure (67%) and this region was joined by Regions 3, 4, 9, and sub-Region 5S in having a larger percentage of optimally scoring files.

Regions 2, 3, 4, 7, and sub-Regions 5R and 6V all had a median biotic structure scores lower than 50%, with the two Region 7 files having particularly low scores (Table

13). Region 2 and 4 had only 40% of files score in the optimal category, while 9 of the remaining 10 regions and sub-regions had the majority of their files score optimally. Similar to physical structure, Region 8 scored comparatively high for biotic structure, with a median score 65% with the vast majority of its files scoring optimally.

With respect to physical structure, these results are not surprising. Most mitigation sites do not emphasize topographic complexity and physical patch types as design elements. However, the results for biotic structure are interesting given that most mitigation activities seem to focus on habitat improvement, namely the enhancement, creation, restoration, or preservation of plant communities. The focus of the biotic structure metrics was on these plant communities, requiring time intensive investigations into the diversity and cover of native and non-native plant species. The poor results from the reference sites for biotic structure suggest that CRAM is poorly calibrated to for this attribute. (CRAM calibration efforts were being conducted at the same time we were assessing mitigation sites; the results of those efforts could not be incorporated into our analyses.) However, even lower scores at mitigation sites indicate that the mitigation projects are not producing sites with optimal biological condition.

The following sections highlight the main findings with respect to each of the 15 individual CRAM metrics.

4.3.3. Individual CRAM Metrics

The distribution of scores for individual CRAM metrics scores varied widely. For example, the percent of assessment area with buffer metric had a median score of 92%, while physical patch richness, biotic patch richness, vertical biotic structure, and native plant species richness had a median of only 42% (Table 14). In general, the majority of metrics had mean scores between 60 and 70%.

The mitigation sites scored lower than the reference sites for all 15 individual CRAM metrics (Figure 46). Differences were most pronounced for the average width of buffer, buffer condition, water source, hydroperiod, hydrologic connectivity, and physical patch richness metrics. There was less difference between mitigation and reference sites for the six biotic structure metrics, percent of assessment area with buffer, and organic matter. However, the reference sites scored relatively low for the six biotic structure metrics and physical patch richness. This indicates a problem with CRAM calibration for those metrics, which will likely be resolved after CRAM is recalibrated. In the meantime, the relatively small difference between mitigation and reference sites for the biotic structure metrics could be either because the mitigation sites are doing relatively well in these areas or that the CRAM metrics are not sensitive to differences in condition that may be present at mitigation sites (perhaps because the reduced range of reference scores). We cannot distinguish between these two possibilities from the data.

The 15 individual CRAM metrics scores varied by SWRCB region (Figure 47). Region 7 shows a particularly distinct pattern, perhaps due to the low sample size (only two files). Although it scored high (similar to the reference sites) for connectivity, percent of assessment area with buffer, and average width of buffer, it scored low on all biotic structure metrics. Region 2 scored particularly low in topographic complexity

(46%) compared to the eight other regions, which averaged between 63 and 71%. Although Region 9 did not score especially high in the overall biotic attribute, it did remarkably well in the two plant metrics, exceeding the reference sites scores.

4.3.4. Wetland Class

The overall Total-CRAM scores varied widely within most wetland classes (Figure 48). Although CRAM was developed for use in a variety of wetland classes, it has not yet been calibrated for all wetland classes. Even the recent calibration effort focused on only two wetland classes, riverine and estuarine. Thus, it is not clear whether differences observed among wetland classes reflect variations in mitigation success, or unresolved issues in the CRAM methodology. Since CRAM has been tested most extensively for riverine wetlands, we expect wetland condition to be most accurately reflected for this class. Appendix 8 discusses differences in CRAM scores for different wetland classes in more detail.

4.4. Habitat Acreage Analysis

The 143 Section 401 orders authorized approximately 217 acres of impacts and required that 445 acres of mitigation be provided; our analyses indicate that 417 acres of actual mitigation acreage was obtained (Figure 49). Overall, 94% of the required mitigation acreage was met. For the individual files, 72% met or exceeded their acreage requirements. Twenty percent (28 files) of the files exceeded their acreage requirements. For 52% of the files (73 files), we determined that the acreage requirements had been met exactly. Twenty-eight percent (40 permit files) of the files did not meet their acreage requirements. As noted in the methods, the obtained acreage values were based on GPS survey of sites where possible, review of files for mitigation bank purchases and other evidence of acreage met, and a combination of field visits and file review where GPS survey of sites was not possible. Roughly one third of acreage determinations were based on each of these approaches.

There was no clear temporal pattern in how well the required acreage was met. The cumulative acreage requirements were shy of being met in most years with the exception of 1992, 1993, and 2001 (Figure 50). In 2001, the acreage requirements were exceeded by 3%, and the acreage requirements were met for the few 1992 and1993 files. These data are comparing total acreage obtained to total acreage required. When the average required mitigation ratios were compared to the average obtained ratios (gain/loss) by year, the results were more variable (Figure 51). The data in this figure represent the averages of individual project mitigation ratios, by year, whereas the previous figure shows the mitigation ratios based on the overall sum of acreages by year. For about half the years the average gains exceeded the requirements, while for the other half they did not. There were two years (1992 and 1993) that met the requirements exactly. Although there were some differences from year to year, there was no general trend, such as earlier years achieving less than the required ratio or later years exceeding it, nor was there ever a very large difference between required and obtained mitigation ratio.

Regions 2 and 8 exceeded their acreage requirements by 2 and 3%, respectively (Figure 52). All other regions fell slightly short of their acreage requirements, meeting from 38% (Region 6V) to 97% (Region 9). The regions that met the lowest percentage of their acreage requirements were Regions 6T and 6V which each had only two files—the lowest sample sizes of all the regions.

While the mitigation acreage fell short of meeting the permit requirements, the regulatory process nonetheless yielded an apparent "gain" of 200 acres on 217 acres of impacts, which is an overall mitigation ratio of 1.92**:**1 (Table 15). However, this simple ratio is based on the assumption that mitigation sites included no existing wetland acreage before the mitigation project was undertaken. In fact, many mitigation actions consist of site preservation or simple vegetative enhancement to existing habitats without any changes in site hydrology; these types of mitigation actions cannot be considered acreage "gains" because there is no increase in wetland area. Since the simple mitigation ratio includes mitigation actions that do not actually increase wetland area, the ratio overestimates the contribution of compensatory mitigation towards achieving a goal of "no net loss" of wetland area. Details regarding acreage gained versus lost for particular projects are provided in Appendix 11. Also provided in this appendix are the raw habitat proportion data collected for each individual mitigation site.

4.4.1. Riparian Jurisdictional Issues

In addition to the problem of including mitigation actions that did not increase wetland area as a wetland "gain," losses in certain habitat types were often compensated for by "gains" in other habitat types, and it was not always clear that the difference was an intended regulatory outcome. In this section, we separate the acreage losses and gains by their component jurisdictional and non-jurisdictional habitats, and attempt to distinguish true losses and gains in area from simple alterations of habitat.

A substantial issue in evaluating acreage shifts is the consideration of riparian habitats that may not necessarily be jurisdictional wetland habitats. While essentially all impacts considered in the wetland regulatory process were to jurisdictional "waters of the United States" (two projects contained mitigation requirements for a combined total of 4.40 acres of upland habitat), 27% of mitigation acreage consisted of drier "riparian" and upland habitats that were outside jurisdictional "waters" (Figure 53). Our "obtained" acreage assessments focused on mitigation habitats and did not include obvious buffer acreage or large conservation tracts that were built into the mitigation requirements. For individual files, part of this non-jurisdictional mitigation acreage may have been unanticipated by regulatory personnel (i.e., site location or mitigation action was different than proposed). However, the majority of this acreage involved site locations and actions that were proposed and subsequently approved. Of the acreage required to compensate for jurisdictional losses directly (buffers excluded), only 64% clearly involved jurisdictional mitigation acreage. Of the remaining acreage, 14% was to include creation, restoration, enhancement, or preservation of upland habitats and the other 22% was ambiguously listed as "riparian" mitigation without distinguishing whether jurisdictional or non-jurisdictional habitat was intended.

In some cases, the mitigation of impacts to jurisdictional habitat by creation of non-jurisdictional habitat may have been intended to deal with particular project circumstances. For example, requiring riparian habitat on a stream bank might be implemented for mitigating wetland impacts in a flood control channels, where affected wetlands are often choked by monotypic stands of cattails/bulrush or non-native invasive species such as peppergrass; in these cases, the agencies might determine that greater environmental benefit could be reached by improving the riparian habitat instead of replacing the lost wetland in kind. Rarely is the reasoning described in the permit files in these cases, however, and even more rarely is a careful analysis of functions lost vs. gained given. In many cases, the emphasis on habitat rather than functions means that wetland losses compensated through non-jurisdictional riparian mitigation result in corresponding shifts in hydrological and biogeochemical functioning.

In some cases, the inclusion of non-jurisdictional habitat as mitigation for impacts to jurisdictional habitat may be due to differences in interpretation of what constitutes "riparian" habitat. "Riparian" habitat can be defined from an ecological or regulatory perspective. In determining riparian *impacts*, a regulatory definition is employed that considers only those riparian habitats within the ordinary high water mark (OHWM) defining "waters of the U.S." (Though the Regional Boards may regulate wider areas under the Porter-Cologne Act and while DFG regulates stream impacts to the "bed, bank, and channel" under Section 1600 of the Fish and Game code, the extent of riverine habitats regulated through streambed alteration agreements is commonly extended to the outer drip line of riparian vegetation; see CDFG 1994). However, in considering riparian mitigation, permittees and their consultants often use an ecological definition of riparian, which includes the entire zone of transition to fully terrestrial habitats. The lateral limits of "riparian" under this definition are vague and can include extensive areas that are beyond jurisdictional "waters." When the mitigation requirements include the ambiguous term "riparian," it is unclear whether the habitats mitigated were intended to be jurisdictional or non-jurisdictional riparian habitat. It should also be mentioned that impacts listed as "riparian" usually involved the entire riverine zone, including the channel itself and the portion of the floodplain and banks deemed within the OHWM. This usage does not conform to the most widely accepted definition of "riparian," defined as the area between fully aquatic and fully terrestrial habitats and not including the actual riverine channel. Additionally, the term *riparian wetland* has been applied loosely and has often referred to both three-parameter wetlands and/or non-wetland "waters" habitats within the OHWM. Our determinations of riparian "waters" were limited to those *non-wetland* portions of the banks and floodplains between the channel and the OHWM.

Aside from the non-jurisdictional acreage found in our site evaluations, the remaining mitigation acreage yielded a net "gain" of jurisdictional acreage with an overall gain/loss ratio of 1.43:1 (Table 15). Given the breakdown of habitat types, the mitigation associated with these 143 permit files resulted in overall net "gains" in both wetland and non-wetland "waters" acreage (Figure 54). There were 181 acres of wetland mitigation compared to 121 acres of wetlands impact, resulting in a net "gain" of 60 wetland acres and a gain/loss ratio of 1.50:1. There were 75 acres of non-wetland "waters" impacted and 105 mitigation acres mitigated for a total gain of 30 acres (mitigation ratio of 1.40:1). The replacement ratio for non-wetland "waters" acreage was slightly lower than that of wetland acreage, but this might be expected given that the "no net loss" goal is focused on *wetland* habitats. Of the non-jurisdictional mitigation acreage, 70% was identified as non-"waters" riparian habitat and the remaining 30% was upland. While the acreage associated with these latter habitat types seems inconsistent with "no net loss" goals, the overall acreage of non-jurisdictional habitats was over and above net "gains" in jurisdictional wetland and non-wetland "waters" habitat. It is possible that some amount of this additional habitat was due to the increased jurisdictional requirements of the DFG; too few *streambed alteration agreements* were present in the permit files to test this. However, mitigation ratios are often proposed as a buffer, a way to account for uncertainty in the success of wetland creation or restoration, or to accommodate temporary losses occurring between impact and the completion of the mitigation project, and other sources of uncertainty. The inclusion of non-jurisdictional habitat in acreage considerations obscures the amount of buffer being incorporated into mitigation requirements.

4.4.2. True wetland acreage losses and gains

In evaluating wetland acreage losses, especially with respect to the goal of "no net loss," it is useful to distinguish between temporary losses and permanent losses, and permit analyses typically make this distinction. Temporary losses can result in important impacts to wetland resources and services (and thus should be mitigated), but they do not result in the permanent loss of wetland acreage.

Similarly, not all mitigation projects result in true wetland acreage gains. As mentioned above, mitigation consisting of habitat preservation does not increase the extent of wetlands. Habitat enhancement also does not increase wetland acreage, even though it may increase the functions and services performed by an existing wetland. On the other hand, habitat creation clearly results in increased wetland acreage. We also consider wetland restoration to result in increased wetland acreage. This increase is a matter of perspective, since restoration by definition occurs in areas that once supported wetland habitat. However, since there was no wetland at the site immediately before the restoration project, we consider this to be a gain in wetland acreage.

To provide an assessment of true losses and gains of wetland acreage, we compared the acres of permanent impacts (true losses) to the acres of creation and restoration mitigation (true gains). In total, 76% of the impact acreage was permanent and 24% was temporary. In contrast, 65% of the total mitigation acreage consisted of creation or restoration mitigation while 24% involved habitat enhancement and 11% was preservation (Figure 55). We did not include any large upland conservation/preservation areas associated with these permit files since these were usually required by FWS for impacts to endangered species and were tangential to the wetland impact/mitigation requirements. Comparing these true losses with true gains, there was a net gain in overall acreage (Table 16).

Most (82%) creation and restoration projects involved jurisdictional acreage. The jurisdictional acreage proportion was lower for enhancement projects (58%) and preservation areas (48%). For jurisdictional "waters," there was a net gain in overall acreage (Table 16), with an overall gain/loss ratio of 1.37**:**1. Both wetlands and non-wetland "waters" habitats experienced gains of acreage (Figure 56). The overall replacement ratio for wetland impacts was 1.38**:**1 while the ratio for non-wetland waters was 1.35**:**1.

These results suggest that at least for overall acreage, mitigation required by the SWRCB and other regulatory agencies appears to be resulting in net gains of wetland acreage across the State. However, there are at least two reasons was may have overestimates acreage gains. First, many sites categorized as "creations" were in fact enlargements of existing wetlands, with both the created and pre-existing "waters" included in the reported mitigation acreage. Second, our GPS surveys yielded best-case acreage estimates since we erred on the side of overestimation rather than underestimation when delineating site perimeters.

The above findings for cumulative mitigation acreage do not indicate how well "no net loss" of acreage is being achieved by individual mitigation projects, or if large gains from certain projects are compensating for net losses in others. In fact, while 64% of permits resulted in acreage gains, 20% of the permits resulted in net acreage losses (Table 17). Thirty-three percent of the projects had net acreage losses in jurisdictional "waters," while 22% had losses for wetlands. Comparing permanent impacts to creation and restoration mitigation, only 41% of the projects yielded acreage gains while 39% resulted in net losses of acreage (Table 18). Almost half of the projects indicated net losses of jurisdictional "waters" habitats, and over one quarter of the projects (28%) resulted in net losses of wetlands.

To determine if the projects with disproportionately large acreage gains or losses were skewing the results, we removed the five projects with the biggest acreage gains and the five with the biggest acreage losses from the analysis. Following this step, net acreage gains were still found with an overall gain/loss ratio of 1.7**:**1 (compared to 1.9**:**1 for all projects). For jurisdictional "waters," the gain/loss ratio was the same as before (1.4**:**1), but for wetlands it was higher, at 1.7**:**1 (compared to 1.5**:**1 for all projects). While there were substantial deficiencies in habitat acreage for 20% of the projects, the large mitigation ratios required by the regulatory agencies have been successful in achieving overall net gains in wetland acreage within California.

4.4.3. Regional Comparisons

In our previous study within SWRCB Region 4, Ambrose and Lee (2004) found that net gains in overall acreage and in wetland acreage had been obtained within SWRCB Region 4. The results from this project indicate that these findings were consistent across the State. However, in that Region 4 study, Ambrose and Lee found an overall net loss in jurisdictional acreage, with roughly 50% of the mitigation acreage consisting of drier riparian and upland habitats that were outside "waters of the U.S." This finding was not consistent across the State. When separated by the 12 Regions and sub-Regions of the SWRCB, our habitat acreage data show that most regions yielded net gains in both overall and jurisdictional acreage (Figure 57). Consistent with Ambrose and Lee (2004), Region 4 experienced a net loss of jurisdictional "waters of the U.S.," with over half (53%) of the mitigation acreage consisting of non-jurisdictional habitat. Sub-Region 5F and the two sub-regions of Region 6 also had net losses in jurisdictional acreage, though Region 6 included just four files, and the loss for six projects of sub-Region 5F would not be apparent if all three sub-regions of Region 5 were combined. Sub-Region 5S was similar to Region 4 in that approximately 50% of the mitigation acreage (46%) was non-jurisdictional. However, unlike Region 4, Regional 5S had a net gain in jurisdictional acreage. For Region 7, 28% of the mitigation acreage was non-jurisdictional; however, like sub-Region 5S, this was in addition to net jurisdictional gains. Region 2, for which we assessed more permits than any other region, experienced the greatest "gain" in jurisdictional acreage. Sub-Region 5S had almost the same number of assessments as Region 2, and nearly as many impact acres. However compared to Region 2, sub-Region 5S had relatively low jurisdictional gains. This region also has the largest number of mitigation bank projects, and had a mean required mitigation ratio lower than Region 2 (Figure 14). Regions 5S and 7 achieved the highest cumulative gain/loss ratio of all the regions (2.91**:**1 and 2.90:1, respectively). Region 4 was also unique in requiring mitigation for impacts to non-"waters" habitat (coastal sage scrub and alluvial fan scrub uplands).

For three of the southern California regions, wetland acreage made up a relatively low percentage of the regulated impacts and mitigated "gains" (Figure 58). The impacts in Region 4 were mostly to non-wetland "waters" habitat (79%). In Regions 8 and 9, wetlands comprised just 45% and 29% of impacts, respectively. On the other hand, wetland habitats comprised 9%, 49% and 61% of the respective jurisdictional "gains" in Regions 4, 8, and 9. Nearly all impacts in Region 1 were to jurisdictional wetlands, and these were compensated almost entirely through comparable wetland mitigation. Region 9 had the highest overall gain/loss ratio (3.20**:**1), while Regions 4 and 7 and sub-Regions 5F, 6T, and 6V all experienced net losses of wetland acreage. While all Regions except 7, 5R, and 6T had some amount of upland mitigation acreage, Regions 2, 4, and sub-Region 5S were notable in this regard.

4.5. Combined Acreage, Compliance and CRAM Results

Throughout the preceding sections, we have condensed our results into simple summaries of success, partial success, and failure. Although these summaries do not reflect the richness of the full results, they simplify comparisons across different aspects of the project. Most (72-76%) of the assessed permit files were successful in meeting their acreage requirements and other responsibilities related to permit compliance, but few (19%) were considered optimal in terms of wetland condition (Table 19). Thus, permittees are largely following their permits (although one-quarter to one-third of the time these are not met), but the permit conditions that are being met are not resulting in compensatory mitigation projects that are similar to natural wetlands.

Since acreage and overall permit compliance are normally used as the primary indicators of regulatory mitigation success (i.e., post-mitigation functional evaluations are rarely performed), it is important to explicitly evaluate the relationship between these indicators and the condition of the mitigated wetland. Simply meeting acreage requirements did not ensure overall permit compliance (Figure 59; $p=0.612$, $r^2=0.002$); not only was there no overall trend, there was a wide range of compliance values for projects meeting 100% of their acreage requirement. Similarly, there was no relationship between percent acreage met and CRAM score for wetland condition (Figure 60;

p=0.169, r^2=0.015). The range of CRAM conditions for projects with 100% acreage met was even broader than for compliance. Clearly, including sufficient acreage in a project, which is relatively easy to accomplish, had little influence on whether the project would be accomplished as required or if it would produce a high-quality wetland.

Although compliance with the acreage requirement was not correlated with CRAM score, general compliance with permit conditions was. Mean 401 compliance score (Figure 61; p=0.000, r^2=0.126), mean percent of 401 conditions met (Figure 62; p<0.001; r^2=0.207), and mitigation plan compliance (Figure 63; p=0.001, r^2=0.150) were all significantly correlated with wetland condition. However, the low r^2 values indicate the relationships between the variables were not very strong, with the compliance data explaining only 13-21% of the variance in the overall CRAM scores. Clearly, other factors influence the condition of mitigation wetlands, but compliance with permit conditions appears to have some influence.

Since some permit conditions are more administrative in nature while others are directly focused on mitigation site performance, it is possible that certain categories of permit conditions might have a stronger relationship to wetland condition than others. Separate regression analyses were performed to compare the four condition categories deemed the most relevant to the CRAM outcome (Figure 64). No significant relationships were found between the overall Total-CRAM scores and the mean scores for the site implementation (p=0.219, r^2=0.027), site maintenance (p=0.297, r^2=0.068), site protection (p=0.743, r^2=0.005), or success & performance standards (p=0.052, r^2=0.091) condition categories. Most of the "conditions" included in these categories came from mitigation plans, rather than the regulatory permits themselves. When additional regressions were performed just for the set of conditions found in the mitigation plans, the relationship with the Total-CRAM score became significant for success & performance standards (p=0.024, r^2=0.086). However, as with the other significant compliance relationships, the r^2 value was very low. This suggests that while compliance with performance standards is somewhat correlated with a positive CRAM outcome, the relationship is not very strong. Given the recent emphasis on success and performance standards in permitting and mitigation requirements, this latter result might seem surprising. However, the lack of a relationship highlights the fact that CRAM condition success means achieving the appropriate hydrological, physical, and ecological conditions at the site, while most performance standards are focused primarily on vegetation success. As a final test, we investigated the relationship between performance standard compliance and the CRAM biotic structure attribute scores: this is the portion of CRAM most closely focused on vegetation success. No significant results were found (p=0.196, r^2= 0.042, for average 401 compliance; p=0.639, r^2= 0.006, for average 401 percent-met). Thus, it seems safe to conclude that while compliance was weakly correlated with CRAM, adequately meeting the permit conditions, even those performance-based standards, does not guarantee the mitigation site will be a well functioning wetland. This implies the need for on-going development of more appropriate standards which will ensure a stronger connection between permit conditions and overall functional development of mitigation wetlands.

An analysis of these 143 files by permittee type (developer, industry, Caltrans, municipal, private, and state/federal) revealed some clear differences in both mitigation requirements and outcomes (Table 20). As was mentioned earlier, Caltrans was distinguished from other state and federal permittees because of the large number of permits they receive and the uniformity in the types of projects involved (mostly bridge crossings). In general, state/federal permittees had the highest mean impact acreage, were assigned among the lowest mitigation ratios, had the lowest obtained mitigation ratios, and had the lowest 401 compliance scores, though they had slightly better scores for mitigation plan compliance. Despite having lower permit requirements and compliance, state/federal permittees achieved the highest Total-CRAM scores. On the other hand, developers and industry-related permittees had relatively low mean impact acreages but were assigned the highest mitigation ratios, scored in the middle for permit compliance, and had the lowest Total-CRAM scores, although the difference between lowest and highest Total-CRAM scores was not great. Municipal and private entities had lower mean impacts (private had the lowest of all permittee types), while their mitigation requirements and mitigation outcomes were near the middle of the range. Caltrans projects had impact acreages near the middle of the range, but like other state/federal agencies had low required mitigation ratios, lower obtained ratios, and higher CRAM scores.

It is not clear if the regulatory agencies assign mitigation requirements differently depending on the type of applicant, or if these mitigation ratios reflect the different types of impact or mitigation projects. For Caltrans, most permitted impacts involved bridge installation and repair projects. Due to the prevalence of temporary impacts for such projects, the mitigation required was often a 1:1 ratio and involved mere vegetation plantings in the associated channel. The CRAM scores for such mitigation projects are often high because of the pre-existing conditions in the channel. Other state or federal permittees might blend their mitigation responsibilities into larger restoration objectives and their actions are not as constrained by the typical concerns of "for profit" entities.

Industry permittees stand out in Table 20 as having exceptionally high mitigation ratio requirements, up to an order of magnitude higher than some other permittee types. This was due primarily to two files. The first involved the complete relocation of a stream channel from one side of a landfill site to the other. Only the loss of the channel itself was considered impacts (2.9 acre narrow strip of "waters" with no accounting of floodplain impacts), while the mitigation requirement included the new channel plus a wide non-"waters" floodplain and the banks of the stream, for a total of 44.0 required acres (required ratio of 15.2:1). The other involved 0.035acres of impacts and 4.3 acres of mitigation, a required mitigation ratio of 122.9:1. Had these two outliers been eliminated from this analysis (and Table 20), the required mitigation ratio for industry permittees would have been 2.0:1 and the obtained ratio would have been 2.9:1. Overall, industry, municipal, and private permittees exceeded their mitigation acreage responsibilities, while developer, Caltrans, and state/federal permittees fell short.

We include in Table 20 a summary statistic calculated by multiplying each file's obtained acreage value by its respective Total-CRAM score ("Average CRAM-Adjusted Acreage" in the last row of the table). The purpose of this calculation was to adjust the mitigation acreage according to the condition of the site. For example, if a one-acre mitigation site had a 100% CRAM score, it would get "credit" for one acre. On the other hand, if the CRAM score was 50%, the site would get "credit" for only one-half acre, since its condition was not optimal. This is a simple, albeit relatively crude, method for adjusting raw acreages to account for the condition of the habitats produced. A similar approach has been suggested for the Hydrogeomorphic (HGM) assessment method (Brinson and Rheinhardt 1996, Hauer and Smith 1998).

Because CRAM scores were less than 100%, the Average CRAM-Adjusted Acreage was substantially lower than the simple acreage gain estimate. We reported earlier that these 143 permit files impacted a total of 217 acres of impacts and obtained 417 of mitigation acreage. Adjusting acreages by CRAM scores, the resulting mitigation acreage dropped to 225 acres (Figure 65). Although the mitigation acreage is substantially lower, it still indicates more adjusted acreage obtained as compensatory mitigation than acres lost.

5. Conclusions

Impacts to wetlands in California are regulated by a variety of different agencies and regulations. Although the principle objective of this study was to investigate statewide mitigation success under the CWA Section 401 Water Quality Certification program, it is not possible to evaluate the success of the State's 401 Program in isolation from the actions of other agencies, particularly the U.S. Army Corps of Engineers and the California Department of Fish and Game. This is particularly true because most 401 permits "invoke" the mitigation plan for the project, which encompasses requirements from the suite of agencies regulating the project. To a large degree, then, the findings of this study relate to the general compensatory wetland mitigation process in California.

We have organized this discussion into a series of major issues. We start with the two major components of the 401 Program that we evaluated, permit compliance and wetland condition. Included in the section on wetland condition is a discussion of how permit conditions could influence the success of wetland mitigation. Next, we discuss how mitigation resulted in the replacement of different habitat types and differences in results among the Regional Boards. We then discuss issues related to mitigation banks. The final section considers the question of whether "no net loss" of wetland acreage and functions is being achieved in California.

5.1. Permit Compliance

Overall, compliance with 401 permit conditions relating to compensatory mitigation was reasonably high, though by no means perfect. Using a strict interpretation of compliance as having to meet each condition to 100% satisfaction, 46% of the files with 401 conditions met 100% of those conditions, with another 50% at least partially in compliance. On average, 73% of a project's 401 permit conditions were complied with in full. Although this percentage is fairly high, it is worth noting that the legal standard would be 100% compliance with all conditions, so fewer than half of all mitigation projects were in full compliance.

The comparable figures for mitigation plan compliance were lower, with only 16% of the files with mitigation plan conditions meeting all their permit conditions, and a mean by-file score of 68% of conditions met. Ambrose and Lee (2004) found that about 2/3 of files for the LARWQCB met 100% of their permit conditions. This value is not directly comparable to the current study, however, because the compliance evaluations of the two studies differed substantially[9]. In the current study, fully meeting all conditions is a fairly high standard, particularly considering the fact that some conditions were extracted from the mitigation plan. In reviewing the mitigation plan, we had to judge what was a "condition" rather than having the conditions described explicitly. In addition, in many cases there were more than 20 or 30 conditions, ranging from straightforward implementation conditions to complex performance standards. Even a relatively minor shortcoming in one standard would prevent a project from achieving perfect compliance.

A more flexible way to judge permit compliance is to evaluate how well condition were met on a graded scale rather than using a yes/no criterion, thereby allowing for a fractional score (e.g., a particular condition was 75% completed). The average 401 compliance scores, according to this definition of compliance, were slightly higher than the corresponding "percent-met" scores, with a mean score of 84% across all files. For mitigation plan compliance, which includes the requirements of all regulatory agencies, the overall average compliance score was 81%. Regardless of which aspect of compliance was used (average scores or percent-met scores, 401 permit or mitigation plan) most projects largely met their permit requirements.

When separated by compliance category, most of the average 401 compliance scores ranged from about 76% to 85%. Conditions relating to third-party mitigation requirements (mostly acreage or credit requirements) had a high average score (around 99%) while monitoring and submission requirements yielded a lower average score (about 59%). Acreage requirements were usually assessable, but for the other condition categories, a significant number of the conditions (regularly between 25% and 50%) could not be determined. Many of the permit conditions did not directly relate to mitigation actions that promote proper site functioning. When those categories of permit conditions were removed from the analysis (i.e., only those conditions relating to site implementation, site maintenance, site protection, and performance/success standards were included), both 401 and mitigation plan compliance scores averaged about 80%.

With compliance scores averaging about 80%, it appears that permit compliance has not been a substantial impediment to the success of compensatory wetland mitigation required by 401 certifications. We encountered a few files with significant compliance shortcomings, and 13 such files were excluded from our study because the mitigation projects were never undertaken, despite project impacts. However, most mitigation projects met most of their permit conditions, or at least met the permit conditions that were assessable.

[9] In the Ambrose and Lee study, conditions from the 401 permits that were not related to mitigation were included in the assessment and the evaluation did not include any "invoked" conditions from other permits. We altered our methods for assessing compliance in the current study to provide more focus on compensatory mitigation, at the same time examining the entire set of mitigation requirements.

5.2. Wetland condition

Understanding how wetland mitigation sites function is a key component of assessing whether the goal of "no net loss" of wetland acreage and functions has been met. In this project, we used the California Rapid Assessment Method (CRAM) to assess the condition of mitigation wetlands (as well as reference wetlands). Although CRAM is specifically designed to assess wetland condition rather than function, since it is based on a one-time "snapshot" of the assessment wetland, we view it as a reasonable indicator of wetland function.

Only about 19% of the permit files we assessed were considered successful with respect to overall wetland condition, based on overall CRAM score greater than 70% (i.e., "optimal" category based on the overall CRAM scores of relatively undisturbed reference wetlands). These results indicate that the vast majority of wetland mitigation projects did not result in wetlands with optimal condition. While 19% is a low success rate, it is somewhat higher than that found in previous studies (although the variation is likely due to differences in the identification of success criteria). Sudol (1996), using a different assessment method (the HGM assessment method), reported 0% success in wetland mitigation projects in Orange County, California. Ambrose and Lee (2004) reported a success rate of 2% for the Los Angeles/Ventura region using a previous version of CRAM. Although it is possible that the statewide success rate is somewhat higher than reported by Ambrose and Lee, the difference is more likely due to Ambrose and Lee's use of a different cut-off for optimal condition (80% rather than 70%), suggesting that their results for LA/Ventura are comparable to the current results for the entire state. CRAM is still under development, and future refinements will undoubtedly occur. It may be difficult to compare directly the earlier applications of CRAM. Nonetheless, it is clear that few mitigation wetlands have the same conditions as relatively undisturbed natural wetlands.

Mitigation sites tended to have relatively high CRAM scores for the "buffer and landscape context" attribute but lower scores for hydrology, physical structure, and biotic structure. As discussed above, some of this variation may be due to differences in the relative effectiveness of CRAM for each of these attributes, but when compared with reference site scores, median mitigation scores were substantially different across the attributes. For example, for buffer and landscape context, the median mitigation score was 80% of the reference. For hydrology, the median mitigation score was 69% of the reference. For physical structure, the median mitigation score was 67% of the reference. For biotic structure, the median mitigation score was 76% of the reference. Mitigation sites appear to do worst in this comparison for hydrology and physical structure. As CRAM is calibrated and refined, more detailed comparisons among attributes will be possible.

As has been found in other studies (Craft et al. 1999, 2002, 2003, Gray et al. 2002, Kentula et al. 1992, Simenstad and Thom 1996, Warren et al. 2002, Zedler and Callaway 1999), we expected to see some increase in the condition of restored wetlands over time. We lacked data on wetland age or the specific date of implementation; however, we evaluated the effect of age on the condition of mitigation wetlands using the "year of certification", under the assumption that projects were likely to be implemented shortly after certification and that this was a reasonable surrogate for the age of a mitigation site. There was no relationship between year of certification and total-CRAM score. At least two factors might be expected to influence this relationship, and they probably work in opposite directions. On the one hand, regulatory practice has evolved since 401 certifications (or waivers) were first issued, and one might expect CRAM scores to improve over time. That is, as regulators changed the way they reviewed projects (e.g., adding permit conditions in order to improve mitigation), these improvements should have led to higher CRAM scores over time. On the other hand, one might expect older mitigation projects to score higher because they have had more time to mature and develop optimal wetland conditions. Other studies (e.g., Craft et al. 2003) have demonstrated that wetland structure and functions increase over time since restoration. In addition, some workers have argued that monitoring should be required for at least ten years to give the mitigation wetland time to develop so that any deficiencies would be more apparent. There was a slight suggestion that the youngest mitigation sites (certification date of 2002) did not achieve as high a CRAM score as older sites; however, no other pattern was apparent. Because there was no trend in CRAM scores over time, it was not clear if either – or both – of these factors were acting. However, any improvements in wetland condition that might have been caused by improved regulatory practice clearly were swamped by other factors.

5.2.1. Permit conditions

Permit conditions guide mitigation projects to produce the types of wetlands needed to compensate for losses due to impacts. The conditions set the parameters of the mitigation project and, in theory, as long as these conditions are complied with, the mitigation project should provide appropriate compensation. In practice, compliance with permit conditions was not correlated with CRAM score, even when we considered only the permit conditions most directly related to mitigation performance, or when compliance with performance standards was compared to CRAM biotic structure. In other words, high rates of permit compliance did not guarantee optimal, or even high, wetland condition.

Does this mean that permit conditions do not influence the success of wetland mitigation? Probably not. However, it does appear that the conditions typically included in 401 permits and mitigation plans do not ensure that the mitigation wetlands have optimal condition, even when there is compliance with the permit requirements. Although a more detailed examination of the relationship between compliance and wetland condition might provide some additional insight into this relationship, the general conclusion is likely to remain: a permittee can do everything required by a 401 permit and mitigation plan yet still produce a mitigation wetland lacking important characteristics.

There are three areas of permit conditions that we suggest could be improved. First, permit conditions need to focus on broader set of wetland characteristics. Currently, permits and mitigation plans focus largely on the vegetation component of wetlands, in particular the percent cover and survivorship of native plant species. Extensive planning goes into determining appropriate species to plant, developing planting configurations, maximizing plant survival and growth, and preventing non-native plant species. All of these are important. However, wetland ecosystems incorporate many aspects beyond plant cover, and the production of a well-functioning, sustainable wetland requires broader considerations (Ambrose 1995). Permit conditions should focus on the full suite of wetland functions and services (see Section 6.1.1).

In general, the metrics used in CRAM could serve as an initial guide to the types of wetland characteristics that could be incorporated into 401 permits. These metrics were selected by an experienced group of wetland experts to identify key aspects of wetland condition. While CRAM metrics do not include all aspects of a wetland that should be considered in permit conditions, they identify aspects to consider for future permits.

Second, permit conditions should support closer tracking of jurisdictional losses and gains. In previous work in Region 4 (Ambrose and Lee 2004), we found that jurisdictional habitat (those within jurisdictional "waters of the United States") was being replaced with non-jurisdictional habitat, with the net effect of a loss of jurisdictional habitat. The current study confirmed that result for Region 4 but did not find an overall net loss of jurisdictional habitat statewide. Nonetheless, 401 certifications are rarely clear and precise about the types of habitats being impacted and replaced through mitigation. If a simple habitat classification scheme (e.g., Table 2) was used consistently in 401certifications, file documents, and the agency database, the accounting between habitat types lossed versus those gained through mitigation (i.e., created, restored, enhanced, or preserved) would be much clearer. This would help ensure that permit conditions require compensation appropriate to permitted impacts.

Finally, wetland mitigation might be improved if permits and mitigation plans included more conditions specifying success criteria/performance standards. Remarkably few permits included these types of permit conditions, and even when they were included in a permit, there were not many separate conditions specified. The lack of performance standards in the permits leaves more opportunity for a permittee to interpret the intent of a permit in ways that may not originally have been intended.

5.3. Changes in habitat types and acreage

In previous assessments of the success of wetland mitigation projects, there has been little consideration of the fact that the habitats under consideration vary in their regulatory status. To address this problem, in Ambrose and Lee (2004) we distinguished between different types of habitats, and especially between jurisdictional and non-jurisdictional habitats, which allowed us to investigate "no net loss" with respect to acreage and individual types of wetland habitat. In the present study, we again evaluated impacts and mitigation according to the different types of habitats affected.

Our jurisdictional habitat evaluations demonstrated that, while essentially 100% of the regulated acreage losses were to jurisdictional "waters of the United States" (including wetlands, jurisdictional riparian habitats and other non-wetland "waters"), almost 30% of the mitigation "gains" involved riparian and upland habitats that were not jurisdictional "waters." After isolating the jurisdictional "waters" portion of the mitigation acreage, the resulting overall gain (permanent losses versus creation gains) still gave an overall mitigation ratio of 1.4:1. However, when individual files were considered, only 36% had net acreage gains, 17% replaced their acreage exactly, and 47% of the files resulted in net acreage losses. This issue appears to be particularly important for riparian habitats, where there are wide-ranging definitions of wetland/upland boundaries used across agencies and in a regulatory versus ecological context.

For wetlands specifically, more acres were created than impacted. Forty percent of individual files resulted in net acreage gains (permanent losses/creation mitigation), and 28% resulted in net losses of wetland acreage. Our estimates of wetland habitat at mitigation sites represent the best-case scenario because we assumed no existing wetland acreage at the mitigation sites, and we did not apply a strict three-parameter wetland delineation test. More acres of non-wetland "waters" were also created than impacted. Seventeen percent of individual files resulted in net acreage gains, and 46% resulted in net losses. Thus, for both jurisdictional wetlands and non-wetland "waters," our results indicate that there has been a net gain in acreage overall. However, a quarter to a half of all individual files still failed to replace the acreage impacted.

This study confirms the findings of Ambrose and Lee (2004) that overall, the cumulative acreage of compensatory mitigation projects exceed the cumulative impacts. However, within the Los Angeles/Ventura Region, our previous study found that over half the mitigation acreage consisted of drier riparian and upland habitats that were outside jurisdictional "waters of the U.S." In this study, we found that, while there was substantial non-"waters" mitigation acreage, this was over and above the net gains of jurisdictional acreage that were obtained.

Although acreage is an important component of the goal to have "no net loss" of wetlands, the goal also encompasses wetland functions. The achievement of "no net loss" of wetlands is discussed further in Section 5.6.

5.4. Differences among regions

We found no significant differences in permit compliance among SWRCB Regions. There was a hint in the data that Regions 8 and 9 might have slightly higher average 401 compliance scores, and Regions 2 and 3 slightly lower, but these differences were not significant.

We discovered that some Regional Boards (e.g., Regions 4 and 9) considered shading for bridge/crossing projects to be a permanent impact, while others (e.g., Region 5) considered only the actual bridge footings as permanent impacts with no mitigation required for shading except for bridges that were very low relative to the stream/floodplain elevation.

With respect to wetland condition of mitigation sites, some regional differences were apparent. There was little difference in Total CRAM scores among the regions with large sample sizes, except that Region 2 had a slightly lower mean score than some of the other regions. Differences in proportions of mitigation files in optimal, suboptimal, or marginal/poor condition were more distinct. The underlying cause(s) of the regional differences in mitigation wetland conditions are not clear. There was a slight (non-significant) indication that Regions 2 and 3 had lower permit compliance scores. However, this seems unlikely to explain the differences since Region 3 was typical in its distribution of wetland conditions, and there was no relationship between compliance and wetland condition in the overall study. Differences in the geographic distribution of different wetland types might explain at least part of this trend. Region 2 had more depressional and estuarine wetlands, which had the lowest mean CRAM scores, than other regions. In addition, Region 2 includes a major urban area, which seems likely to constrain many of its mitigation projects. However, Region 4 also includes a major urban area. Although its proportion of optimal sites was higher than Region 2's and its proportion of marginal/poor sites was lower, Region 4 did have more marginal/poor sites than some of the other regions. In contrast to the slightly lower scores we found, previous work by Breaux et al. (2005) for 20 mitigation sites in Region 2 found relatively high condition scores using the WEA method. Differences in the two studies could be due to differences in the sites sampled or methodology (e.g., WEA appears to result in consistently higher scores than CRAM). In particular, scores for estuarine sites appeared to be different with the two methodologies.

There were regional patterns in mitigation acreage requirements. While most regions experienced net gains in acreage, sub-Regions 5F and 6T had net losses, though both of these had relatively few permit file evaluations. The acreage for just two regions (Regions 2 and 8) exceeded the cumulative mitigation requirements, while the remaining regions fell short of their respective requirements. Compared to other regions, Regions 7 and 8 stood out as having relatively high cumulative impact acreages given the number of permits involved. Region 7 had one file involving particularly large impacts. This result for Region 8 is especially noteworthy since that Regional Board had required the lowest cumulative mitigation ratio (1.15:1). Regions 2, 5S, and 7 had required the greatest cumulative mitigation ratios.

Interestingly, the results for Region 4 were consistent with the Ambrose and Lee (2004) study, in that over half that region's mitigation acreage (53%) consisted of non-jurisdictional riparian and upland habitats. While Region 4 had a small net gain in acreage overall, there was a net loss in jurisdictional acreage (14.6 acres lost, or 40% of the acreage not replaced). Region 8 and Sub-Regions 5F, 6T and 6V also experienced net losses of jurisdictional acreage. Sub-Region 5S was similar to Region 4 in that approximately 50% of the gains were non-jurisdictional, though in this case, it was over and above a net gain in jurisdictional acreage. For Region 3 and sub-Region 6V, the proportion of non-jurisdictional habitat was approximately 31% and 38%, respectively, of the total obtained mitigation acreage, and for all other Regions and sub-Regions the non-jurisdictional acreage was 30% or less.

5.5. Mitigation banks

Our results indicate that compensation at mitigation banks yielded slightly higher average CRAM scores (though non-significant) than project-specific mitigation (see Appendix 9). The lack of statistical significance could be due to differences in sample size between mitigation types (formal banks, informal banks, and project-specific mitigation) and the wide range of habitat types which increased variation within each mitigation type, as well as any natural variation in these responses. For CRAM, the largest differences between banks and project-specific mitigation projects were in the hydrology and buffer/landscape context attributes. There were no differences in physical and biotic structure attributes between banks and project-specific mitigation. Given the importance of hydrology for mitigation wetlands, as noted above, our results indicate that banks should continue to be evaluated as a potential improvement to the mitigation process. There are a number of likely benefits associated with the consolidation of habitats in mitigation banks, and while our results do not show a strong or significant difference in CRAM scores, the trends are informative.

Ideally, a more focused evaluation of banks should be designed to compare a similar number of bank and file-specific projects of similar habitat classes within a particular region. This would reduce outside variation in CRAM scores, or other measures of condition or function, and provide a more definitive comparison of the relative effectiveness of mitigation banks. However, given the actual distribution of mitigation bank projects within the state this could be difficult. We found that most banks were clustered in the Central Valley, with a small number of banks being developed in the Santa Rosa area, and others found sporadically across the state. A focused study within the Central Valley is most likely to yield high sample sizes. Similarly, banks vary in terms of habitat types, with most focusing on depressional, vernal pool, and riparian wetlands. There has not been clear distinction in some banks to differentiate vernal pool mitigation from other depressional wetlands. More consistent classification in this regard would be useful for future assessments of banks and other mitigation projects.

Although CRAM scores include aspects of biogeochemical functions, suggesting that mitigation banks are performing these functions adequately, this does not consider the geographic distribution of these functions. Mitigation policy has traditionally prioritized on-site mitigation over off-site mitigation, but many agencies have adopted policies allowing for off-site banks because of their potential benefits. However, some wetland functions may not be replaced on a regional basis as effectively as others. In particular, water quality improvement, such as nutrient recycling or pollutant removal, provide an important service to a local watershed, and the creation of a similar function in a distant watershed does not provide the same spatial distribution of benefits. This may be especially relevant for mitigation banks in relatively undeveloped areas. In these cases, there will be relatively little gain in water quality improvement because water quality will already be good in these undeveloped areas. In contrast, the loss of services related to water quality at the impact site could be substantial from some permitted impacts (such as a residential development). When focusing on this particular service, other mitigation strategies in the same watershed as the impact, such as removal of concrete lining from a channelized stream, might provide a better balance to the loss of water quality improvement services while maintaining geographic proximity to the impact (see Recommendations 6.1.2 and 6.1.5). It is also possible that Best Management Practices (BMPs) required by the Regional Boards for stormwater permits might provide adequate replacement for these services. Because we focused on mitigation associated with 401 permits, our analyses cannot be used to evaluate the effectiveness of BMPs in this context. However, if stormwater BMPs are to be used to compensate for lost wetland functions, there should be specific analyses supporting their use in the 401 permits; in particular, there should be a discussion about how the stormwater BMPs would be used to replace lost functions.

5.6. Evaluating "no net loss"

California state and federal policies have established goals of "no net loss" of wetland area or function. Our results indicate that, statewide, the overall acreage of compensatory mitigation projects has exceeded the impacted acreage of wetland and other jurisdictional habitats (see Section 5.3). Although the overall mitigation acreage exceeded the overall impacted acreage, a substantial portion of the files resulted in net acreage losses. In addition, wetter jurisdictional areas that were lost were frequently replaced by drier riparian and upland habitats.

In addition, achieving the goal of "no net loss" of wetland acreage does not ensure that wetland functions were protected. Despite the obvious importance of assessing compensatory mitigation in terms of wetland functions, there have been remarkably few functional assessments in a regulatory context. In part, this may be due to the lack of a standard method for functional assessments. There is a long history of wetland evaluation methods being developed for regulatory purposes, but most methods have had severe limitations. The Hydrogeomorphic (HGM) Assessment Method was developed specifically to address many of these limitations, and it is well suited for functional assessments in a regulatory context. In fact, Sudol (1996) used an early version of the HGM approach to evaluate Section 404 mitigation sites in Orange County. However, HGM requires regional models for each wetland type, and many compensatory mitigation projects in California would not have had an appropriate model available for assessment. The California Rapid Assessment Method (CRAM) is being developed to fill the need for a simple method to assess wetland condition (as a proxy for function) at a wide range of wetland types in California. In this study, we used CRAM as an indication of the function of wetland mitigation sites, based on the assumption that a wetland in good condition should also function well.

A more fundamental problem with assessing "no net loss" of wetland function is the study designs available for use. Assessments of wetland condition conducted at a mitigation site years after the mitigation was completed, such as we had to do, cannot indicate whether the policy of "no net loss" of wetland function has been achieved. Determining the change in function requires measuring function at the impact site before and after impact to assess loss of functions, and at the mitigation site before and after mitigation to assess gain. Such an approach is not possible in an after-the-fact assessment such as the present study; in fact, we know of no large-scale survey that has been able to adopt this approach.

Although our assessments of the current condition of the mitigation sites indicate whether the ultimate outcome of mitigation actions resulted in a high quality/functioning wetland, our data cannot address how much of the quality/function was *caused by* the mitigation action. It is likely that all current "function" is not attributable to the mitigation activities completed at a site; in many cases, this is certainly the case. For example, many mitigation actions consisted of simple vegetative enhancements to pre-existing stream habitats, and other "creation" projects involved slight enlargements of existing wetlands. Had comparative CRAM evaluations been done at these mitigation sites *prior* to the mitigation actions, many of the resulting pre-mitigation scores might have been no different than our post-mitigation assessments. This would be especially true for hydrological and biogeochemical function, since most mitigation efforts focused on improving vegetation. In addition, we decided to give a mitigation site credit for an existing channel at sites that were adjacent to existing streams but did not include any actual stream habitat. Although these sites were physically and hydrologically connected to the channel, in no way did they "create" the functions that were identified based on CRAM scores. Despite the many cases where it was clear the mitigation actions did not create all of the wetland functions at the site, we could not assess how much gain in function might have occurred due to the mitigation actions because we had no comparable data on the pre-existing functions at each mitigation site. Similarly, we had no information on the loss in function caused by the impact site. Lacking an assessment of both gains and losses, a rigorous evaluation of "no net loss" of wetland function was not possible.

In our study of mitigation success for the Los Angeles/Ventura region, we tried to evaluate "no net loss" of wetland function directly by assessing the beneficial wetland services lost due to project impacts and gained through mitigation actions (Ambrose and Lee 2004). Through site visits and careful review of files, we gained insights as to the nature of the functional losses and gains. Through our resulting structured qualitative assessment, we determined that over half of the mitigation projects (66%) failed to compensate adequately for the full suite of beneficial services lost through the project impacts. Unfortunately, time constraints prevented us from performing a similar assessment in the present study. However, our anecdotal observations suggest that the results would have been similar if we had performed the same qualitative assessment.

Although a rigorous assessment of net change in wetland function was not possible in this study, the relatively low CRAM scores for condition suggest similar levels of function at the mitigation sites. As noted in the methods, reference sites were not chosen to be indicative of pristine conditions but were representative of typical wetlands found in their region. The lower scores at mitigation sites suggests that the mitigation actions may not be fully compensating for the functions lost at the impact sites. However, this conclusion remains unconfirmed pending a study using the proper study design.

6. Recommended Administrative and Regulatory Changes

The recommendations from our study are separated into five main categories (Table 21). First, we present recommendations aimed at improving mitigation requirements. These recommendations concern mainly permit conditions, but also issues of the location of mitigation projects and the tracking of habitat gains and losses for a project. Second, we present recommendations under the general heading of "Information Management." These recommendations concern improvements to the State Board's permit tracking database (either the existing database, or a modified database), improvements to permit archiving, and improvements to tracking the progress of mitigation projects. Third, we present recommendations to improve the clarity of permits. Fourth, we recommend that the goal of "no net loss" be assessed in a more effective manner. Finally, we present recommendations concerning coordination with other agencies.

To the extent possible, we have tried to ensure that the recommendations included in this section stem directly from the work done under contract to the SWRCB[10]. However, our previous study for the Los Angeles Regional Water Quality Control Board (Ambrose and Lee 2004) had a similar goal, and we produced an extensive series of recommendations in a Guidance Document to the LA Board (Ambrose and Lee 2004b); there are inevitably many similarities between those recommendations and the recommendations presented here. In addition, we acknowledge the influence of many other studies of mitigation effectiveness (e.g., Kentula et al. 1992, DeWeese and Gould 1994, Race 1985, Breaux et al. 2005, Allen and Feddema 1996, Sudol 1996, Zedler 1996, Breaux and Serefiddin 1999, Breaux and Martindale 2003), as well as comments by State and Regional Board staff.

Although the recommendations presented below are based on work done during this project, early results and recommendations were discussed with State Board staff. In addition, there are other ongoing efforts to improve processes associated with the 401 Program. Thus, a number of these recommendations are already being implemented or are planned for implementation in the near future. For example, two database efforts, the California Integrated Water Quality System Project (CIWQS) and Wetland Tracker, would incorporate some of the issues identified in these recommendations.

6.1. Improving Mitigation Requirements

The success of compensatory mitigation depends fundamentally on the mitigation requirements specified by the regulatory agencies. Our study found relatively high levels of compliance with mitigation permit conditions. In addition, there was no relationship between compliance with permit conditions and the condition of wetland mitigation sites. It appears that compliance with permit conditions is no guarantee that a mitigation wetland will have high condition or function. Perhaps the most effective way to improve the success of compensatory mitigation would be to include permit conditions that are more likely to lead to mitigation projects with higher levels of wetland condition and function.

6.1.1. Permit conditions should ensure complete compensation for the **full suite** *of wetland functions and services lost*

Wetland functions include a broad range of physical and biological processes. Many of these functions, such as flood water attenuation, groundwater recharge, water quality improvement (i.e., pollutant removal), and support of wildlife, provide valuable services for humans. To ensure that compensatory mitigation provides full compensation

[10] Thus, this is not an exhaustive list of how we think mitigation practice could be improved, but rather represents recommendations addressing issues we encountered during the present study.

for lost wetland functions and services (also called values), discussion of project impacts and mitigation should be framed in terms of functions and services.

Note: in this section, "wetland" is used in the broad, non-regulatory sense as a shortcut to the regulatory terms "waters of the United States and adjacent wetlands."

6.1.1.1. Permit conditions should place more emphasis on performance standards

401 permits include conditions addressing various aspects of compensatory mitigation projects, one of which concerns the performance of the mitigation project. We found that the number of success and performance standard conditions included in most 401 permits was relatively limited; only 15% of all permit conditions that were related to mitigation addressed success or performance standards. Thus, the basis for determining whether the mitigation project is successful is not specified in most 401 permits; instead, performance standards are contained in other permits (e.g., 404 or 1600 permits) or the mitigation plan.

In many cases, other permits or, especially, the mitigation plan may be an appropriate location for performance standards. For example, the details about a particular mitigation project are often not known until the mitigation plan is produced. However, the absence of particular success criteria or performance standards in the 401 permit leaves the Regional Boards with less explicit input into the nature of the mitigation project. If the Regional Boards want to emphasize particular elements of the mitigation project (for example, see Recommendation 6.1.2), the 401 permit is the most effective place to require these.

6.1.1.2. Performance standards should include hydrological and biogeochemical conditions as well as vegetation

When performance standards are included in 401 permits, they often focus on aspects of vegetation or invasive plants. We do not recommend that fewer performance standards be required concerning native vegetation or invasive plants. In fact, the current attention on vegetation and invasive plants is well-founded on scientific studies of mitigation success. However, some vegetation issues need clarification. In particular, adoption of a specific and consistent definition of invasive species would be a substantial improvement in permit planning and monitoring.

Despite the importance of vegetation and invasive plants, there are other important wetland functions that should be included as performance standards (see Section 2.2). General summaries of wetland functions, as well as functional assessments such as the HGM assessments, include hydrology, biogeochemistry[11], and ecological functions. Permit conditions, however, rarely focus on hydrology or biogeochemistry. Since hydrological and biogeochemical standards have not been widely used to date,

[11] Wetland biogeochemical functions include processes that transport or transform different materials (see Section 2.2.2 for more detail). The breakdown of organic material and nitrogen cycling are two common biogeochemical functions. These functions support important services such as removal of nutrients or contaminants from water.

there are few examples of standards that would be appropriate, and this is an area that would benefit from work to develop standardized conditions. Performance standards for hydrological conditions could include ensuring proper hydrology through saturation/water level monitoring, mitigation site delineations, and so forth. Biogeochemistry conditions could be structured around soil measurements (bulk density, salinity, pH, redox, etc.) Water quality measurements, including parameters such as nutrients and total suspended solids, could also be made upstream and downstream of the impact site to determine water quality impairment and upstream and downstream of the mitigation site to determine water quality improvement. Compared to other wetland functions, the potential for mitigation site to exhibit proper biogeochemical and water quality functioning depends heavily on the proper landscape positioning of the site.

In addition, performance standards should include conditions that cover different ecological scales, such as population, community, and ecosystem conditions (Ambrose 1995). For example, at the population level, performance standards could require successful reproduction for key species (especially habitat-forming species such as trees) to ensure sustainable populations.

Although we found that, in general, hydrological and biogeochemical functions of wetlands were not addressed as completely as they should be in permit conditions, the necessary focus depends on the specific circumstances. In some cases, vegetation standards may need greater emphasis. Some trends were apparent for different wetland types. For example, riparian mitigation tended to be focused too heavily on vegetative plantings without appropriate hydrological improvements, while some seasonal/depressional mitigation tended to involve excavation and seeding without enough plantings.

6.1.2. Ensure that mitigation projects compensate for losses in water quality (pollution) improvement services

Wetlands can remove pollutants, including excess nutrients, metals and bacteria, from water flowing through the wetland. This service is frequently cited as a key benefit of wetlands. Given the focus of Section 401 of the Clean Water Act on water quality, the pollutant removal capabilities of wetlands should be considered explicitly in 401 permits. This may best be achieved by including a separate analysis for impacts to water quality, as well as the identification of how these impacts would be mitigated. (We use "water quality" here in the general sense relating to pollutants in water, rather than in the broader regulatory sense.)

Water quality services provided by natural wetlands may be replaced incidentally by the compensatory mitigation projects that are typically required by 404 and 401 permits. However, without a specific consideration of these services, it is impossible to evaluate if these services are replaced fully. Systematic consideration of the effects of different mitigation alternatives on water quality may lead to a shift in priorities for mitigation for the Regional Boards. For example, treatment wetlands are often discouraged as a form of mitigation because ostensibly pristine wetlands could be replaced by urbanized wetlands with high pollutant loads. This may be a valid point from the perspective of ecological function, and a high-quality wetland may be required to mitigate impacts to ecological functions. But from the perspective of pollutant removal, treatment wetlands may be ideal for compensating for impacts to water quality.

We discuss three examples where water quality services are especially likely to be overlooked.

First, the compensatory mitigation projects we studied focused largely on the provision of habitat, and the upper, drier riparian habitat that is commonly a part of compensatory mitigation projects (see Section 4.4.1, Figure 54) provide relatively little water quality benefit. While such habitats may replace many of the lost functions in the broader regulatory sense of “water quality,” they may not replace the functions that remove pollutants. To ensure the replacement of lost water quality functions, it may be necessary to add elements to mitigation projects in addition to the normal conditions focusing on habitat replacement. For example, a portion of the mitigation wetland near the water inflow point(s) might incorporate design features used in treatment wetlands, or treatment wetlands might be required outside the boundaries of the wetland used for general mitigation. It may be appropriate for the Water Board to require treatment wetlands for all large development projects to ensure that the permitted projects do not result in water quality impairment (i.e., pollution).

Second, a specific analysis of water quality aspects might alter the mitigation required for some projects concerning “low quality habitat.” The term “low quality habitat” may be appropriate when considering the value of a habitat for plants or animals. However, from the perspective of water quality, such habitats may have significant water quality functions. For example, channels surrounded by development can have high potential for water quality remediation. Mitigation for impacts to “low quality habitat” tends to be limited because of the focus on habitat, but such mitigation may not adequately replace the water quality improvement functions performed by the original habitat. The Water Board should be careful to ensure that all functions performed by “low quality habitats,” especially water quality improvement functions, are fully replaced.

Third, mitigation banks may be effective tools for replacing lost habitat functions, but, as currently designed, they may not provide adequate compensation for water quality impacts, particularly for services such as floodwater attenuation and pollutant removal. For many wetland functions, maintaining the function in the same region may be appropriate. The loss of water quality improvement functions or floodwater attenuation in a local reach may have far-reaching local consequences which would not be compensated by a mitigation bank in a different location (see Section 6.1.5).

6.1.2.1. Projects involving channelization, the installation of concrete linings, and cut and fill operations resulting in large scale drainage modification/culvert installation should be discouraged

When a stream segment is channelized, lined, or culverted, the hydrological, biogeochemical, and ecological functions and services lost are very difficult to mitigate. While this has been widely recognized and stream “improvements” are now discouraged, such projects are still occurring, often because the surrounding area is already urbanized and the stream is considered degraded and consisting of "low value habitat." This may be an accurate assessment with respect to habitat-related functions and services, but such streams can be extremely beneficial with respect to water quality improvement (notably water pollution remediation). Large scale development projects with drainage modification can have particularly high net water quality impacts because the loss of water quality function is coupled with increased runoff and pollution input.

6.1.2.2. Promote channel daylighting and complete channel restoration projects (concrete removal) as compensation for biogeochemical impacts

One reason that losses of stream function are difficult to mitigate is that one cannot easily create stream systems in existing upland habitats. Most projects that we evaluated which called for riparian creation were, in fact, riparian vegetation projects within upland areas with little or no alteration of site hydrology. Some mitigation projects have attempted to create stream function by widening existing streams, or by creating side channels in upland areas that are fed by water diversions. Such projects can result in limited functional gains. Yet the purpose of Section 401, along with other aspects of the SWRCB and RWQCB regulatory mandates, is to protect beneficial uses in general and water quality in particular. Where possible, adding performance standards that relate directly to biogeochemistry and water quality functioning is important, but reconsidering overall mitigation strategies may lead to more successful compensation for such impacts.

In our previous study (Ambrose and Lee 2004), and again in the present study, we found that projects involving the complete restoration or relocation of channel segments or cross-sections, particularly those involving the removal of concrete linings, can result in significant gains in hydrological, biogeochemical, and ecological functions and services. In urban setting (where concrete-lined channels often occur), habitat values can be limited due to landscape context. Nonetheless, channel relocation/restoration projects can still provide substantial ecological functions and services, as well as providing mitigation opportunities in a setting where such opportunities can be limited.

Although channel daylighting or complete channel restoration could open up new opportunities for replacing lost stream functions, such projects could be quite expensive and thus might not be feasible for all permittees. Large developers might be able to undertake projects such as these on an individual basis. In addition, mitigation banks could be developed to enable the benefits of channel daylighting or complete channel restoration to be realized even for relatively small individual projects. Mitigation banks have many advantages over permit-specific mitigation, but most existing bank projects have been focused on ecological functions and services, including habitat for threatened and endangered species. Because the benefits they can impart to water quality improvement, and "no net loss" in general, the SWRCB should promote the development of mitigation banks involving full channel restoration (including daylighting and the removal of concrete linings). Channel daylighting and complete channel restoration might have relatively limited benefit if conducted in only small areas; mitigation banks would provide a mechanism for pooling efforts to achieve a more meaningful project.

6.1.3. Improve accounting of the habitat types lost and gained

Permit documents should use a standardized habitat classification. Currently, the SWRCB's Section 401 internal guidance document indicates that five different waterbody types should be used in the Project Information Sheet: wetland, riparian, streambed, lake, and ocean. (For each waterbody type, the guidance document indicates that acres of permanent and temporary impacts should be recorded.) Although these are all generally recognized waterbody types, our review of impact and mitigation projects suggests that a somewhat different classification could make it easier to track mitigation of impacts to jurisdictional habitats, which is an important step towards determining whether the goal of "no net loss" of wetland area and function is being achieved.

"Riparian" is a particularly problematic term. Impacts and mitigation concerning riparian habitats need to be more clearly defined to ensure that non-jurisdictional areas are not used to mitigate for jurisdictional impacts. The SWRCB's Section 401 internal guidance document defines riparian as "stream or lakeside jurisdictional water (below line of normal high water), vegetated, but not jurisdictional wetland (may be either wet or dry most of the time)." This definition seems to clearly restrict the use of "riparian" to jurisdictional "waters," as is appropriate for regulatory use with respect to 401 and 404 permits. Impacts are generally delineated according to this definition, although occasionally we found that the entire jurisdictional area, including the stream itself, was termed "riparian." However, mitigation planners have regularly applied a broader definition of "riparian" that includes both jurisdictional and non-jurisdictional habitat. Permits and mitigation plans seldom distinguish between these two habitat types. Thus, a non-regulatory definition of "riparian" is often being used in a regulatory situation. As a result, impacts to jurisdictional riparian habitat have often been compensated for by mitigation within non-jurisdictional riparian or even upland areas, resulting in a net loss of jurisdictional riparian acreage and values.

A more useful terminology would clearly distinguish between areas classified as "waters of the United States" versus areas that are not "waters of the United States" (for example, see Table 22). These main categories are distinguished based on regulatory considerations. Within each of these main categories, appropriate general habitat classifications are identified. These categories are based on those currently presented in the SWRCB's Section 401 internal guidance document (and, in fact, those exact categories could be used if desired). The categories presented in Table 22 reflect the types of habitats frequently named in wetland permit documentation, as well as general types of wetlands recognized by wetland scientists.

Besides standardizing the way habitats are described in wetland permits, Table 22 provides a structure for tracking the areas of losses due to permitted impacts and gains from mitigation. The losses and gains (in acres and/or linear feet) should be recorded for wetland/riparian creation, restoration, enhancement, preservation for each of the habitat types, including transitional habitat and upland buffer areas.

6.1.4. Mitigation projects should have appropriate landscape context

One of the clearest differences between the CRAM evaluations of compensatory mitigation wetlands sampled in this study and their reference wetlands was their landscape context. In CRAM, landscape context contains four metrics, one for connectivity and three related to the amount and quality of the buffer around the wetland. The CRAM manual defines these concepts as:

> The **connectivity** of a wetland refers to its potential to interact with other areas of aquatic resources, such as other wetlands, lakes, streams, lagoons, etc., and their surrounding environs at the watershed or embayment scale, and to the likely relative importance of the wetland in the landscape context. Wetlands within a watershed or in the same embayment are often functionally connected by the flow of water, such that they have an additive influence on the timing and extent of flooding, filtration of pesticides and other contaminants, and the movement of wildlife.
>
> For the purpose of CRAM, a **buffer** is a zone of transition between the immediate margin of a wetland and its larger environment that is likely to help protect the wetland from anthropogenic stress. Areas adjoining wetlands that probably do not provide protection are not considered buffers. Buffers can protect wetlands by filtering pollutants, providing refuge for wetland wildlife during times of high water levels, acting as barriers to the disruptive incursions by people and pets into wetlands, and moderating predation by ground-dwelling terrestrial predators. Buffers can also reduce the risk of invasion by non-native plants and animals, by either obstructing terrestrial corridors of invasion or by helping to maintain the integrity and therefore the resistance of wetland communities to invasions.

Mitigation wetlands frequently had poorer buffers and/or connectivity to adjacent wetlands (especially for riparian habitats). Because buffers and connectivity relate to conditions outside mitigation project boundaries, they may not typically be considered carefully in mitigation planning. However, poor buffers or low connectivity will adversely affect the functioning of a mitigation wetland. Mitigation projects should be planned with adequate buffers and functions.

While adequate buffers and adjacent open space are extremely important for wildlife and other ecological functions and services, they may be less important when the purpose of the mitigation site is focused on flood control and water pollution remediation.

6.1.5. Offsite mitigation should be within the same catchment, or at least the same watershed

While some functions can be replaced in another watershed, other functions (such as water quality improvement, floodwater retention, habitat connectivity) cannot. When mitigation occurs outside the catchment in which the impact occurs, some functionality in that system is lost. In some cases, mitigating those losses in a nearby catchment in the same watershed would provide adequate compensation for downstream impacts. For example, if impacts to a wetland reduces its ability to attenuate floods, then mitigation in the same catchment would provide the most appropriate compensation, but mitigation somewhere else in the same watershed would at least provide similar protection against downstream flooding.

The problem of mitigation occurring outside of the catchment or watershed in which the impact occurred is especially prevalent with third-party mitigation. As discussed earlier (Section 5.5), mitigation outside the watershed, as occurs with many mitigation banks, may be especially problematic because the mitigation may occur in relatively undisturbed watersheds where these services may be less important.

6.2. Information Management Recommendations

In this section, we discuss recommendations to improve the management of information associated with 401 permits. The performance of this study revealed the difficulty of retrieving specific permit files. Of the 429 files we sought, we could locate only 257. The difficulty in locating files had a variety of causes, ranging from limitations in the database to the physical management of hardcopy permit files. This section also includes recommendations designed to improve the ability to track the progress of mitigation projects.

6.2.1. Improvements to Database

Our review of mitigation projects depended on information from the SWRCB database for project identification. We used the database to select projects indicating compensatory mitigation requirements, and using the project information contained therein, attempted to identify and locate the physical permit files at either the Regional Boards, or Corps district offices. During the course of our extensive work with the database, we identified a number of areas that could be improved.

Note: Recommendations 6.2.1.1to 6.2.1.4 can be implemented with the existing database. Although the existing database contains fields for the most important information concerning 401 permits, we have identified some areas that could be improved. These improvements would require that the database be modified, as reflected in Recommendations 6.2.1.5 to 6.2.1.11.

Also note that, as an early action response to the preliminary findings of this study, the SWRCB began documenting ACOE file numbers in the database (Recommendation 6.2.1.2) in May 2005. To enhance data quality, file numbers are being entered, discrepant field values are rechecked (Recommendation 6.2.1.4), and full project titles are being entered (Recommendation 6.2.1.1). In addition, we recommend a number of additional fields be added to the database. Many of the fields recommended are included in the California Integrated Water Quality System (CIWQS), an agency-wide data management system now being deployed that will store all water board data, and in “Wetland Tracker,” which Region 2 hopes to begin requiring soon as a permit condition in a pilot program.

6.2.1.1. Full project titles should be entered into the database

The location of permit files was much more arduous than expected because the information in the State Board database was not sufficient to identify a unique project in the Regional Board's or Corps of Engineers' respective databases. Generally, the project title was abbreviated, and therefore, lacked many relevant key words that would have facilitated cross referencing with other databases.

6.2.1.2. Additional critical information should be included within the "notes" field

Much additional information is available in the 401 permit that would have been useful in the cross-referencing and identification of files using the Regional Board's or Corps's respective databases. Information such as the Regional Board's permit ID number, the Corps' 404 permit number, other agency permit numbers, and the county should be entered in the "notes" field of the database.

Note: if the database is modified as recommended, it would include this information as database fields; see Recommendation 6.2.1.6. However, there is no reason to wait until the database is modified to begin entering this information. The SWRCB's Section 401 internal guidance document indicates this information can optionally be included in the "notes" field.

6.2.1.3. Each permit should be assigned a unique numeric or alpha-numeric identifier to be used by both the Regional Board and the State Board

While most Regional Boards assign each project a project identification number, their numbering formats are not compatible with centralized use by the State Board. Hence, these identification numbers have not been included in the State Board's database. A consistent statewide format should be implemented and the State Board's database should include a field for these primary identification numbers.

Note: if a centralized database is developed as recommended (see Recommendation 6.2.1.5), a single permit identifier would naturally be assigned because both the Regional and State Boards would use the same database. However, there is no reason to wait until a centralized database is developed to assign a unique identifier.

6.2.1.4. Database records should be entered using a quality assurance protocol

As would be expected in any extensive data entry project, there were a number of mistakes in the State Board database entries. A quality assurance protocol should be established to double-check entries. This would included, at a minimum: (1) checking whether the permit represented a modified or re-issued certification to avoid redundant data entry, (2) ensuring that all permanent and temporary impact to wetlands and non-wetland "waters" are included and that these are inputted into the correct fields per the established protocol (see Recommendation 6.2.1.8), and (3) checking entries for typographical errors. In many quality assurance programs, a certain percent of the entries (e.g., 10%) are checked independently for accuracy. This protocol would have to be integrated into any future changes to data entry methods.

Although pure entry errors occurred, some database entry errors were due to misinterpretations of the permit information caused by ambiguous wording or the difficulty of having to extract important information that was embedded in the text of the permit (see Recommendation 6.2.2).

6.2.1.5. A central database should be developed for use by both RWQCB and SWRCB to avoid redundant data entry

Currently, the State Board maintains a database for information from all 401 certifications, and some Regional Boards maintain their own independent databases. There is a lack of correspondence between the fields in the Regional Boards and State Board databases. In addition, since much of the information required by the State Board is the same as required by the Regional Boards, there is unnecessary duplication of effort to maintain a series of independent databases.

6.2.1.6. Database records should include fields for all critical information from a permit, and those fields should be adequately populated for every permit

Within the State Board database, project descriptors were often abridged versions of the full titles found in the certification letters, and the county and other agency permit numbers were usually absent. With such limited information, it was difficult to identify and locate the physical permit files at either the Regional Board or Corps offices using their respective databases. The SWRCB's Section 401 internal guidance document specifies "to facilitate cross-referencing, include the U.S. Army Corps of Engineers' (Corps) file number if it is available (Optional)." In practice, we found few files with the corresponding Corps number included. The database should include fields for the 404 permit number and the numbers of other agency permits including the Department of Fish and Game's 1600 permit and the Fish and Wildlife Service's Biological Opinion. In addition, a field should be included for the county and the permittee's consultant (if relevant). In the SWRCB's Section 401 internal guidance document, information such as this is identified as optional additional information that may be added at the Region's discretion; we feel that critical administrative details, such as county and other agency permits, should be required fields in the database.

Additional fields could also be useful in the database. For example, information fields for file attachments for permits, pre- and post- mitigation photos, and so forth would provide a broader view of the project. This information would be useful for later compliance evaluations, and might be entered by the permittee if electronic form submission is adopted (Recommendation 6.2.1.10).

Having full project titles, county of project, and other agency permit numbers would greatly simplify any future efforts to evaluate the 401 program. Perhaps more importantly, though, it would ensure that each project is unambiguously identifiable. Clear identification of projects would be important for any action that needed to check project characteristics, including enforcement actions and (when the database has such capabilities) tracking mitigation monitoring or other compliance activities (such as paying in-lieu fees).

6.2.1.7. Include GPS locations for the impact and mitigation sites in the SWRCB database

The SWRCB's Section 401 internal guidance document indicates that latitude and longitude information would be useful for GIS analysis of impact (discharge) locations; this information is listed as optional. With the ready availability of inexpensive GPS instruments, latitude and longitude should be required for all permits, for both the impact and the mitigation sites. As a minimum requirement, a single point location could be recorded for impact and mitigation site (or each of the mitigation sites, if more than one).

Ideally, a survey-grade GPS would be used to determine the boundaries of impact and mitigation sites. Recent technological advances have made survey grade GPS units relatively affordable, and it would be reasonable to expect all future projects to provide an electronic GIS shape file with the specific boundaries of the mitigation project. This information could be submitted for GIS mapping and analysis by Regional or State Board staff. It would simplify the assessment of compliance with acreage permit conditions.

6.2.1.8. Eliminate ambiguities between permanent and temporary impacts by including fields for "total impacts," "permanent impacts," and "temporary impacts"

Currently, the fields for total impacts and the subset of the total impacts that are temporary are not consistently being applied appropriately. As an example, the fields for wetland impacts include "wetlands" and "wtemp." According to the database entry instructions, the total wetland impacts are to be recorded in the "wetlands" field and the subset of the impacts that were temporary are to be recorded in the "wtemp" field. In practice, permanent impacts were often entered into the "wetland" field and the temporary impacts were entered into the "wtemp" field. Data entry staff should be adequately trained to ensure that these fields are used appropriately. Alternatively, the confusion could be eliminated by having one field for total impacts, one for permanent impact, and one for temporary impacts.

6.2.1.9. Permit conditions should be entered into the database

Tracking the compliance of a compensatory mitigation project would be simpler if the permit conditions upon which compliance will be judged was recorded in the permit tracking database. Having permit conditions in the database would simplify independent studies of compliance. When the database has capabilities for tracking project compliance, having the permit conditions specified in the database would reduce the amount of time needed to understand the crucial permit requirements and determine if they had been met.

Currently, it would be difficult to extract the appropriate permit conditions from the permit file. However, Recommendation 6.3.1 recommends that permit conditions should be clearly delineated in the permit.

6.2.1.10. Have permittees submit permit information in electronic form

Clearly, one of the difficulties of maintaining a database is the time required to enter the appropriate data. If the information needed for the database could be submitted by the permittee in electronic form, staff time needed to enter information would be minimized. Having an electronic form for permittees to fill out would also minimize database entries. Instead of having to enter all information (multiple times when separate databases are maintained by the State Board and each regional board), the basic information would need only to be checked, although additional information (such as permit conditions; see Recommendation 6.2.1.9) might have to be entered by Water Board staff. The form and database could be designed so the information from the form would flow simply into the database.

6.2.1.11. The database should contain information to improve management after a permit is issued

Information management for 401 permits currently seems focused almost exclusively on activities leading up to the issuance of a permit. However, post-permit activities are also critical for a successful 401 program. Better information about the project after the permit is issued would allow Regional Board staff to track the progress of projects and assist compliance and evaluation efforts.

Post-issuance information that could be useful includes:

- The database should track document submissions
- The database should incorporate flags for overdue documents.
- In concert with the fields for specific permit conditions, there should be fields for recording satisfactory compliance with conditions.
- The database should track any enforcement actions undertaken on the permit.

This type of information is included in CIWQS and is being proposed for the Wetland Tracker.

6.2.2. Improve permit archiving

During our previous study of permits at the Los Angeles Regional Board (Ambrose and Lee 2004), we discovered a number of issues associated with the archival of office hardcopy file management. Informal surveys of other Regions suggested that file organization and archiving at the Regional Boards did not support efficient file retrieval, making it necessary to perform our file reviews at the Corps district offices. Issues with hardcopy file management were also apparent in this project when we tried to locate specific files and either had difficulty locating them through the issuing Regional Board or the Regional Board was never able to provide us with a copy of the files.

File archival is obviously important for a retrospective program evaluation such as this study, but it is also essential for tracking permit compliance, including compliance with submissions of monitoring reports. Obviously, it is difficult to establish compliance with a permit if the file cannot be located. Therefore, we recommend that permit archiving systems for each Regional Board be evaluated and improved if necessary.

One particular addition to the database that could help with office hardcopy file management would be a chain of custody field for recording the location of physical permit file folder. This could minimize the possibility of misplacing permit files as they are transferred between staff workstations and short- or long-term filing systems.

6.2.3. Improve tracking the progress of mitigation projects

Various changes to the database could improve its ability to track the progress of mitigation projects after a permit has been issued (e.g., Recommendation 6.2.1.11). However, there are additional activities the Water Boards could undertake to improve project tracking.

6.2.3.1. Track the submission of monitoring reports

Monitoring reports provide a potentially simple and efficient method for assessing the progress, and potentially the compliance, of a mitigation project (see Recommendation 7.3.1). However, our review suggests that this tool is not being used effectively. Monitoring and submission requirements had among the lowest compliance rates of all categories we evaluated. Through a tracking field in the database or other means, monitoring reports (and other submission requirements) should be routinely reviewed.

6.2.3.2. Keep better track of credit purchases

Currently, files for projects requiring mitigation bank or in-lieu fees often lack information about the payment of the required fees. In our assessments we found several examples where the evidence of fee purchases was submitted to one agency but not other agencies (see Recommendation 6.4).

6.2.3.3. Track in-lieu fee payments

We found some examples of in-lieu fee projects in which the money was paid, but not used (yet) for actual mitigation activities. For instance, several payments to the Center for Natural Lands Management were not applied to a mitigation site because no approved site was available at the time of fee payment. Several years had gone by in the interim and those projects appeared to have been forgotten about; at the very least, there was an extended period of temporal resource loss. It would be useful if a record could be made, either in the revised database (see Section 6.2.1.8) or elsewhere, when the payment was made <u>and</u> when the money was applied to mitigation.

6.3. Improve permit clarity

Permit conditions should be written as clearly assessable criteria, with individual conditions for each specific criterion to be evaluated. Permit conditions should be written with a clear and direct method of assessment in mind. Our results suggest that more clearly written conditions would improve the chance of compliance. Presently, some conditions are too vague or may be presented in a way that it is not possible to assess them.

Permit clarity could be improved if a standardized list of permit conditions were developed. A standardized list could incorporate the main characteristics found useful for each type of permit condition. It could be a living document that was revised to incorporate improved knowledge about what permit language did or did not achieve the desired results. It would improve consistency since all permit writers would be working from the same list; we found many examples of permit conditions that covered the same general topic but were worded in different ways. It would improve predictability for permittees and their consultants, since different projects would use the same wording to describe conditions to achieve the same goals. It would also provide permit writers with an overall structure for the types of conditions that might be required, so permit conditions might be more comprehensive. Obviously, standard conditions would often need to be modified to meet the particular demands of a specific project, and not all appropriate conditions could be anticipated. Nonetheless, a standardized list of permit conditions could help clarify the intent of permit conditions.

Creating a standardized list of permit conditions would be possible with moderate effort, but it was beyond the scope of this project. We recommend that a specific effort be made to establish a standardized list of permit conditions, and that this effort include all regulatory agencies responsible for wetland permits.

6.3.1. Important permit information, including impact and mitigation acreage and permit conditions, should be clearly delineated in tables and not buried within the permit text

After comparing the information in the 401 permits and database to the other regulatory permits, we found many cases where the database errors were the result of ambiguous language in the 401 permit. For example, the language of a permit may not have been clear whether two or more distinct impacts were additive or inclusive. Although these were considered database errors, it was clear that the cause was the difficulty in understanding the intent of the permit. The likelihood of such errors is higher when information for the database must be extracted from the text of the permit. Misinterpretations would be less likely if the key mitigation requirements were listed in tables.

6.3.2. Permit conditions should be written so that efforts made in a small portion of the site cannot satisfy the verbatim text of the condition when the intention of the condition was that the efforts would be made throughout the site

In our compliance assessments, we frequently encountered situations where ambiguous phraseology in the permit requirements required that we assign a high compliance score to a mitigation project even though only partial mitigation efforts had been made. As an example, in assessing compliance with a condition that read "must remove invasive plants prior to planting," we had to assign a high score even if we found evidence that invasive plants were removed from only a small portion of the site. When the intention of a particular condition is that the action or success standard would apply to the entire site, the condition should include such specifications ("…throughout the entire site").

6.3.3. Final Mitigation plans (and perhaps all permits) should include a table listing the requirements upon which compliance will be judged

Prior to the approval of the final mitigation plan, all parties should understand and approve the conditions upon which permit compliance will be judged. These conditions have generally been scattered diffusely throughout the text of regulatory permits and mitigation plans. Summarizing these clearly and succinctly would ensure that all parties understand the permits and simplify future compliance evaluations.

Within the permitting sequence, a preliminary mitigation plan is generated before all the permit requirements have been established. Rather than a diffuse and potentially ambiguous presentation of mitigation requirements, the regulatory permits should include a summary table with an explicit statement for each condition included in the permit. Then, after obtaining similar tables from all agencies, the permittee would combine these into a single unified table of conditions to be included in the final mitigation plan for approval. The development of this table should be a collaborative effort with all involved agencies (see Section 6.4) and not left solely to the permittee or consultant. In monitoring reports, assessment of compliance should be centered on this table (see Recommendation 7.3.1).

The table of mitigation requirements should distinguish conditions required by different agencies. In addition, the conditions should be organized within the following categories: (1) Permittee-responsible acreage requirements, (2) third party acreage credit purchases, (3) mitigation site implementation, (4) mitigation site maintenance, (5) site protective measures, (6) success and performance standards, (7) monitoring and submission requirements, (8) invocation conditions (e.g., "follow the 404 permit"), and (9) other/miscellaneous.

6.3.4. Permits should be clear about the meaning of enhancement, restoration and creation

Enhancement, restoration and creation can all increase the amount of wetlands functions in ways that can be appropriate for compensatory mitigation, but the amount and nature of the increase varies, and the likelihood of success also varies. Thus, the terms should be useful carefully and consistently. The term "restoration" is often used in a general sense to encompass all three of these terms, but in permit analyses and language they should be used strictly.

Enhancement refers to changes made to an existing habitat (e.g., wetland) to improve its functions or services. Enhancement does not increase the area of a habitat, which is an important consideration when assessing the goal of "no net loss" of wetland acreage. Because many physical processes may already be occurring before enhancement, enhancement projects may be the easiest to achieve successfully. Because some functions are typically occurring in the degraded habitat before enhancement, enhancement generally doesn't produce as many functions or services (per unit area) as restoration or creation.

Restoration refers to changes made to an area that was once, at some point in the past, the desired habitat (e.g., wetland), but has been converted to a different habitat type. Restoration returns the area to the desired habitat, with the general goal of achieving the level of ecological functioning found in the original habitat. Restoration increases the area of a habitat as well as the amount of functions and services provided by that habitat.

Creation refers to the creation of a habitat in an area that had never supported that habitat. Because none of the physical processes or biological functions characteristic of the habitat, and required to sustain it, occur at the site before the creation, creation can be the most difficult type of "restoration." Whenever wetland creation is required, wetland delineations, or at least proof of inundation or saturation appropriate for wetland development, should be included as permit requirements to ensure a wetland was actually created (see Recommendation 6.3.6).

In its 2004 Final Mitigation Guidelines and Monitoring Requirements, the Los Angeles District of the Corps uses similar definitions, and has a similar assessment of benefits and risks of the different types of "restoration":

> Generally, the physical characteristics of the sites considered determine whether establishment (i.e., creation), restoration, enhancement, or, more rarely, preservation are viable compensatory mitigation options. The categories of compensatory mitigation, as defined by Lewis (1990) are:
>
> Restoration: return to a pre-existing condition.
>
> Creation: conversion of a persistent non-wetland habitat into wetland (or other aquatic) habitat. Two subdivisions are recognized: Artificial (i.e., irrigation required) or self-sustaining.
>
> Enhancement: increase in one or more functions due to intentional activities (e.g., plantings, removal of non-native vegetation).
>
> Passive Re-vegetation: allow a disturbed area to naturally re-vegetate without plantings.

Regulatory Guidance Letter 01-1 used the term establishment instead of creation. The former term will be used in this document for consistency with this Corps Headquarters' guidance. Establishment projects have the greatest potential because, in theory, the full suite of functions performed by that habitat type are established; but they also have the highest risks. Establishing aquatic habitat in an area where it did not previously exist is a difficult proposition. Restoration projects have had a higher degree of success in the Los Angeles District. Despite the uncertainties associated with establishment projects, the Corps usually recognizes establishment and restoration equally when it comes to determining compensatory mitigation credit. Enhancement projects generally receive less compensatory mitigation credit, because enhancement targets particular functions instead of the full suite of functions performed by that habitat type. When enhancement is accepted, the Corps will require that the enhancement improve as many of the functions as possible.

Additional terminology has been used in the recent proposed Mitigation Rule from the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers (71 FR 15520). The proposed rule uses the terms reestablishment and rehabilitation. Re-establishment refers to "the manipulation of the physical, chemical, or biological characteristics of the site with the goal of returning natural/historic functions to a former aquatic resource." Re-establishment rebuilds former aquatic resources and results in a gain in aquatic resource area. Rehabilitation refers to "the manipulation of the physical, chemical, or biological characteristics of the site with the goal of repairing natural/historic functions to a degraded aquatic resource." Rehabilitation results in a net gain in functions, but does not result in a gain in aquatic resource area.

In common mitigation practice, restoration and creation focus on the addition of plants (normally facultative riparian or wetland species) to areas where they do not currently occur. These are not true restoration or creation projects. True creation and restoration projects add hydrological, biogeochemical and ecological functions to a site, typically through topographical modifications and/or the establishment or re-establishment of appropriate hydrology. Section 6.1.1 discusses the need to include the full suite of physical and biological processes in mitigation projects.

Note that one other related term, preservation, is sometimes used in a mitigation context. Preservation occurs when an existing habitat (wetland or other) is protected but not manipulated. Although preservation may be an appropriate component of a mitigation requirement (see LAD ACOE guidelines for an example), preservation does not increase the amount of wetland acreage to compensate for acreage losses, nor does it increase the amount of wetland function or services to compensate for losses of those wetland attributes.

6.3.5. When invasive species removal is required, performance standards should be clear about the goal of invasive species control

In our evaluations, we found examples where invasive species eradication was an important goal of the mitigation and specifically required as a permit condition, and others where invasive removal and maintenance were required so that newly planted native species would have less competition for resources at establishment. However, in many instances, the goal of an invasive removal was not clearly defined, and while eradication may have been the intent, the permit language simply required removal. In such cases, we were forced to assign high compliance scores for the condition (some removal had occurred) even though substantial recurrence may have been observed. For some projects (e.g., site-specific invasive removal projects, or in-lieu fee payments for *Arundo donax* eradication), enhancement involving invasive species control was the entire mitigation project. Permits should be specific for the mitigation goal and the permit language should accurately reflect that goal.

6.3.6. If a wetland is planned as part of a mitigation project, proof of inundation or saturation appropriate for wetland development should be required

We found several examples where one of the regulatory agencies had required verification of wetland hydrology or three parameter wetlands as a specific performance standard. Unfortunately, most wetland mitigation projects did not include such a condition. This condition should be included as a performance standard in all permits involving wetland mitigation.

6.4. Improve the assessment of "no net loss"

6.4.1. Pre- and post-construction functional assessments of impact and mitigation sites should be required to ensure "no net loss" of wetland functions

Much of the interest about the success of compensatory wetland mitigation revolves around the question of whether "no net loss" of wetland area and functions has been achieved. It is very difficult to answer this question definitively with respect to functions without suitable data before any impacts have taken place. In our previous study (Ambrose and Lee 2004), we incorporated a method for assessing the net gain or loss of services, but quantitative, objective conclusions are difficult without appropriate "before" data. Conceptually, the correct way to answer this question is to assess wetland functions at the *impact* site before and after the impact occurs to estimate the loss of functions, and to assess functions at the *mitigation* site before and after mitigation occurs to estimate the gain of functions. These paired before-and-after functional assessments would provide the information necessary to assess a net change in wetland functions.

We recommend that functional assessments be conducted before the construction of any development project or mitigation project to establish the baseline conditions at those sites. Then, as part of the monitoring requirements, post-construction assessments should be conducted.

There are a variety of methods that could be used for a functional assessment. Ideally, the State Board would adopt one particular method so the functional assessments were consistent across the state and could be easily compared and aggregated for a state-wide assessment. Some wetland evaluation methods, such as the Hydrogeomorphic

Assessment Method (Hauer and Smith 1998), have been explicitly designed to incorporate "no net loss" analyses of mitigation projects. Others, such as the newly developed California Rapid Assessment Method (CRAM; Collins et al. 2005), which we used in this study, are readily being applied toward this goal. The method should be useable in a wide range of wetland habitats, quick to apply, and provide scientifically rigorous, objective data.

Although paired before-after functional assessments are necessary for a careful assessment of net change in wetland function, they are rarely if ever undertaken. Besides the general difficulty of funding such studies, this particular study design carries the additional logistical difficulty that the "after" samples must be taken some years after the "before" sample. Despite these difficulties, we feel the paired before-and-after study design is needed to address the key policy question of whether compensatory mitigation under the Clean Water Act is accomplishing the goal of "no net loss" of wetland functions.

There are additional benefits of before and/or after functional assessments, of course. A pre-construction functional assessment of the mitigation site would inform the design of the mitigation project, to help the analyst determine whether the proposed design is likely to result in the desired post-construction functions. A post-construction functional assessment of the mitigation site, such as we performed for this study, would show whether the mitigation project actually produced the desired functions. Even for these purposes, adoption of a standard functional assessment method such as CRAM would increase the value of the functional assessments by allowing the compilation of results across the state.

6.5. Coordination with other agencies

Although the Water Board has responsibility for 401 permits, the entire process of regulating impacts to wetlands and "waters of the United States" is closely coordinated with other agencies, especially the U.S. Army Corps of Engineers and the California Department of Fish and Game. Improved information management might improve this coordination (see Recommendation 7.3.2).

6.5.1. Improve incorporation of final permit information into Water Board files

Although the 401 process is integral to wetland permitting, we found a significant number of files where changes to a project (impacts and/or mitigation) that occurred later in the project planning and permitting were not incorporated into Water Board files or 401 permits (see Section 4.1.1). Our review of permit files suggests that the Regional Board staff have not always been included in the planning decisions that occurred after the 401 permit was issued. The Regional Boards should be active through all phases of the project planning or should at least insist on being copied on all subsequent changes that are approved by the other regulatory agencies. Once finalized, the 401 permit should be updated to reflect the actual impacts and mitigation actions/acreage that occurred, and then the database should be updated.

Although our review focused on 401 permits and the information included in them, it is worth noting that 404 permits should be more specific in mandating that the 401 conditions must be complied with. Currently, some 404 permits contain such language while others do not.

6.5.2. Consider developing an integrated permit

Coordination with other agencies would be maximized if there was a single integrated permit required for projects impacting wetlands or "waters of the U.S." Since there must already be significant coordination among the agencies, an integrated permit might not mean additional work, but it would simplify the permitting process for permittees, it would ensure that all relevant information was available and included in Water Board files, and it would eliminate redundant permit conditions.

7. Recommended Compliance Monitoring Program

The SWRCB contract for this work states that this final report shall "provide recommendations on the necessity, frequency, location, and type of ongoing compliance monitoring." Section 7.1 discusses the need for compliance monitoring based on the results of the present study. The next section discusses whether compliance monitoring might be focused at particular locations, how often it might be needed, and what type of monitoring might be required. In addition, we have some specific recommendations (Section 7.3) concerning monitoring.

Our recommendations about compliance monitoring reflect our own experiences, the scientific literature, and other guidelines. A particularly relevant guideline was produced in 2004 by the Los Angeles District of the Army Corps (LAD USACE 2004). Although directed more at monitoring the progress of mitigation projects, aspects of these guidelines are relevant to compliance monitoring.

7.1. The need for compliance monitoring

The results of this study clearly indicate the need to evaluate the compliance of mitigation projects with their permits. Thirteen of the 257 permits we located had to be excluded because of potential compliance issues. This indicates that up to 5% of the files we reviewed may have significant compliance problems (such as the impact occurring but no mitigation being undertaken).

Our analysis of discrepancies between the 401 permit and information in the permit file identified additional compliance issues. For example, 8% of the 143 files we evaluated had information indicating that the actual impacts were greater than authorized in the 401 permit; overall, there appeared to be compliance issues with **42%** of the files we evaluated.

We found relatively high compliance with third-party mitigation requirements, but substantial lack of compliance with nearly every other category of permit conditions we assessed (see Table 7). Only about 65% of acreage requirements were met. Only about 50% of success criteria/performance standards were met. About 53% of monitoring and submission requirements were met. Moreover, many of the categories we assessed had a high fraction of permits for which the conditions could not be assessed; for example, we could not assess monitoring and submission conditions for more than half of the permits.

These results indicate a definite need for compliance monitoring. Without a significant compliance effort, permittees are failing to comply with a wide range of permit conditions without the Water Board staff knowing about it.

7.2. How should compliance monitoring efforts be focused?

Our observations here are based on inferences gained from reviewing the permit files as well as data on compliance with permit conditions. Data from our analysis of compliance might be used to guide decisions about the most effective places to focus compliance monitoring. However, in considering this information, it is important to remember that ours was a retrospective analysis, sometimes assessing compliance many years after the mitigation project was completed, and as a consequence there were many permit conditions we could not assess. It is possible that there were compliance problems with the permit conditions that were not assessable for us, but we cannot determine that. A more complete assessment of compliance (enforcement) problems should focus on contemporary permits so that all conditions could be assessed.

Our data allow us to identify some areas that seem most likely to have low compliance. For example, we found some differences in compliance for different types of permittee. The lowest 401 compliance scores were State/Federal and Municipal agencies. For mitigation plan compliance, Caltrans and private permittees (individual land owners or commercial entities with small "one-time" projects) joined these two as having the lowest compliance. Industry (corporation-owned factories, landfills, etc.) had the highest compliance scores for mitigation plan compliance.

We also found some regional differences in compliance. Among the different Water Board regions, Region 2 had relatively low 401 compliance and Region 8 had lower mitigation plan compliance. The low 401 compliance in Region 2 appears to be the result of higher expectations and more specific permit conditions in Region 2 compared to other regions rather than the permittees in Region 2 being less diligent. For this reason, compliance numbers alone do not reflect the quality of the mitigation undertaken, since better compliance could be achieved by having fewer permit conditions and less demanding conditions. Among the Water Board regions, Regions 8 and 5F had among the fewest specific conditions in the 401 permit and among the highest proportion of redundant conditions.

The mean 401 compliance differed somewhat among the different wetland types (Figure 66). High gradient riverine habitats had the highest compliance rate. Low gradient riverine, depressional, and lagoon (the latter with only a single example) had intermediate compliance rates. Vernal pools (N=10) and estuarine wetlands (N=1) had the lowest compliance rates.

Although the preceding results provide some guidance in terms of possible areas for focusing compliance assessments, in our view it does not provide a very sharp focus. Compliance issues are spread quite broadly across all aspects of the 401 program, so compliance monitoring will also need to be spread quite broadly. The areas identified as having lower compliance might warrant a particular emphasis during compliance monitoring, but compliance was not so high for most other areas (with the possible exception of third-party mitigation conditions) that it would be safe to assume high compliance with them.

Although we have conducted a detailed assessment of compliance with 401 permits, we have little direct knowledge of the State or Regional Boards' current activities for checking compliance. Our review of information in the permit files suggest that there are substantial compliance issues for which there was no evidence of Regional Board response, but we did not follow up on these instances to determine if the Regional Boards were aware of those issues or had taken actions not evident in the file. Hence, we cannot comment on how current compliance efforts might be re-directed. However, we can identify mitigation monitoring reports as a cost-effective vehicle for evaluating a mitigation project.

Although monitoring requirements were regularly included as 401 permit conditions, and evaluated for compliance when appropriate, the relative scarcity of monitoring reports in the permit files we reviewed suggest that compliance with the monitoring requirement is checked infrequently. Our compliance assessment indicated that conditions requiring mitigation monitoring were met only about 53% of the time; it was unclear whether any enforcement actions were undertaken in response to the absence of monitoring reports. While we were conducting our study for the Los Angeles Regional Board, that region was compiling lists of permit files without monitoring reports and contacting permittees to obtain the reports. This seems like a relatively cost-effective area on which to focus compliance monitoring efforts.

In addition to reviewing submissions, it would be ideal if Water Board staff could undertake periodic site visits to confirm the reported monitoring results. However, we recognize that Water Board staff time is extremely limited, and it may not be feasible for existing staff to conduct site visits. Recommendation 7.3.2 suggests an organization that could undertake these site visits.

7.2.1. Frequency of compliance monitoring

There are different phases of a mitigation project, and different types of compliance monitoring would be required for each phase.

In the early construction phase of a mitigation project, many decisions are being made and many activities are being undertaken. Compliance monitoring during this phase would ensure that the mitigation project took shape as envisioned by the 401 staff and described in the mitigation plan. In addition, many compliance problems identified during this early phase are more likely to be resolved easily than if they were to be identified much later.

The best type of compliance monitoring for the early phase would be on-site inspections. However, as noted above, it is unlikely that existing Regional Board staff would have the time to conduct on-site inspections, although perhaps this would be possible for the largest or most complicated projects. (If an independent monitoring cooperative was established, as recommended in Section 7.3.2, they could conduct some site inspections.) In the absence of on-site inspections, mitigation monitoring reports are critical for the determination of permit compliance, especially for the period during and shortly after the initial construction of the mitigation site. This is because the proper hydrology should be established, conditions relating to the preparation and implementation of the mitigation, as well as the basic trajectory of the site, should be discernable. Extensive photographs would assist in documenting the progress of construction and compliance with the permit conditions. The regulatory agencies often require that as-built drawings are submitted during this time, but a full report is needed to identify any initial problems, such as incorrect hydrology or invasive species establishment. Although the permittee (or its consultants) should monitor a mitigation site frequently for the first year after its construction to ensure rapid identification of any unexpected developments or problems, and inform the regulatory agencies if these are identified so that appropriate corrective action can be taken if necessary, a formal annual report should provide the regulatory agencies with sufficient information. It is important to identify potential problems early; if deficiencies are not identified until the end of the monitoring period, there will be limited opportunities for remediation.

After the initial post-construction period, we expect changes to occur at a slower rate (e.g., Zedler and Callaway 1999). Annual monitoring would be appropriate to document the development of the site, identify any shortcomings, and to verify compliance with the permit requirements.

In general, on-site inspections would be the best way to confirm that all permit conditions had been met, but Regional Board staff should be able to assess compliance by careful review of monitoring reports. The most efficient use of staff resources would be to rely on annual monitoring reports through the end of the monitoring period, then confirm the report findings by an on-site inspection. However, on-site visits are often not possible due to staffing constraints. Office review of the monitoring reports would be sufficient in most cases, as long as the monitoring reports were focused and informative. Because we feel that good monitoring reports are essential for an efficient evaluation of permit compliance, we have included a specific recommendation on this topic (Recommendation 7.3.1).

7.3. Specific monitoring recommendations

7.3.1. Mitigation monitoring reports should be streamlined and focused around demonstrating compliance with an established list of permit conditions

Mitigation monitoring reports take a wide variety of forms, from very simple to extensive and detailed. In general, they tend to be large detailed documents that restate much of the background project-related information, often provide highly detailed descriptions of the monitoring methods and results of vegetation monitoring data, and only diffusely and often ambiguously address compliance related issues. The focus on methods and detailed results detract from their utility for assessing compliance with permit condition. The annual monitoring reports should focus on the success-related issues and should clearly document compliance with an established list of permit conditions (see Recommendation 6.3.3).

Because agency permit files are often incomplete and lack key documents (such as the mitigation plan), we do not feel that all background information (such as the restating of project impacts and expected mitigation strategies) should be eliminated from monitoring reports. However, such information should be well organized and succinct. We suspect that the extraneous nature of existing monitoring reports has been an impediment to the regulatory review of these documents.

Some of these issues have been addressed recently in the USACE's Regulatory Guidance Letter No. 06-03 on minimum monitoring requirements (available at http://www.usace.army.mil/cw/cecwo/reg/rgls/rgl06_03.pdf.). Clear guidance on the desired structure and content of the monitoring reports could simplify the task of assessing the progress of mitigation projects, and in particular it would greatly improve their utility for assessing compliance with permit conditions.

7.3.2. Form a multi-agency cooperative for compliance monitoring and project tracking

In California there are typically three to five regulatory agencies involved in the wetland regulatory process: the Corps, the Regional Board, the DFG if the project involves stream or lakebed impacts or State-listed endangered species, the FWS if there are federally-listed endangered species issues, and the Coastal Commission if the project occurs within the Coastal Zone (or the Bay Conservation and Development Commission [BCDC] if the project is in the San Francisco Bay region). Each agency is responsible for independently monitoring compliance with its own permits, including compliance with compensatory mitigation requirements. Compliance monitoring is complicated by the fact that not all agencies receive all required documents (e.g., final mitigation plans, monitoring reports, deeds, proof of payment/credit purchases, and documents describing planning changes) from the permittee. Permittees frequently submit documents to a single agency that they view as the "lead" agency for their project.

Following up on permit compliance includes the time consuming reorientation to the various projects, keeping track of document submissions and other communications, the careful review of mitigation monitoring reports, and site visits, plus maintaining the files and updating the database. Yet each agency suffers from perennial understaffing and limited resources. The result is that little monitoring of compliance is done by any agency.

To help address this problem, we recommend that regulatory agencies establish a multi-agency cooperative to monitor compliance and track wetland losses and mitigation success across the State. This cooperative could report the results of its evaluation to each of the regulatory agencies and serve as a central repository for permit-related information. This could improve compliance monitoring and free-up staff resources.

Costs would be distributed and redundancy would be eliminated, thus maximizing the efficient use of limited resources.

In our study, we reviewed 200-300 permit files and thoroughly assessed almost 150 files within one year with a limited staff. With limited funding from each agency, a small staff could receive and manage copies of documents from across the state, visit a significant percentage of sites as agents of all agencies, and report their findings to each agency. After issuing their permits, project managers would be freer to concentrate on new projects instead of simultaneously tracking multiple existing projects. Such a cooperative would ensure that compliance monitoring would actually get accomplished, while avoiding substantial redundancy of effort and promoting the centralization of permit file information and tracking.

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9. Tables

Table 1. Reference Site information

Site ID	Name	Region	Latitude	Longitude	Research Group*	Wetland Type
WCAP99-R026	Coldwater Creek	1	41.84611	124.02750	CCG	Riverine Low
WCAP99-R029	Clark's Creek	1	41.80861	124.11667	CCG	Riverine High
WCAP99-RO92	Prairie Creek State Park	1	41.40000	124.05806	CCG	Riverine High
BC-Y	Blue Creek	1	41.20000	123.54000	CCG	Riverine High
WCAP99-R037	Horse Linto	1	41.00893	123.60197	CCG	Riverine High
11921	Grove's Prairie	1	40.95667	123.48528	CCG	Riverine Low
WCAP99-R077	Canoe creek	1	40.29490	123.90290	CCG	Riverine Low
FREE 11130	Freeman Meadow	5R	39.67333	120.62075	SFEI	Riverine Low
WCAP99-R003	Trout Creek	1	39.53852	122.86077	SFEI	Riverine High
WCAP99-R008	Rattlesnake Creek	1	39.49388	122.86368	SFEI	Riverine High
WCAP99-0614	Austin Creek East	1	38.53603	123.07221	SFEI	Riverine Low
Ref. 16	Asbury Creek Lo	1	38.35028	122.53793	UCLA	Riverine Low
Ref. 17	Asbury Creek Tributary	1	38.34976	122.53352	UCLA	Riverine High
CA02-0604	Upper Petaluma	2	38.20767	122.56683	SFEI	Estuarine
CA02-0608	Point Edith	2	38.04353	122.07233	SFEI	Estuarine
CA02-0612	China Camp	2	38.01475	122.49280	SFEI	Estuarine
Ref. 22	Briones Regional Park	2	37.92129	122.16454	USF	Riverine High
Ref. 5	Walker	6V	37.90109	119.12983	UCLA	Riverine Low
Ref. 4	McGill Trail Head	6V	37.54992	118.80384	UCLA	Riverine High
Ref. 3	Fish Slough	6V	37.48043	118.40321	UCLA	Seep & Spring
Ref. 9	TNC Vernal Pool Reserve	5F	37.39987	120.45229	UCLA	Vernal Pool
Ref. 10	Chowchilla	5F	37.17623	120.07051	UCLA	Riverine Low
101	Upper Scott's Creek	3	37.07404	122.23793	CCG	Riverine Low
106(a)	East of Seal Bend	3	36.82000	121.77000	CCG	Estuarine
12339	Carmel Valley River	3	36.52243	121.81748	CCG	Riverine Low
12330	San Antonio River	3	35.89417	121.07361	CCG	Riverine Low
310-ADC	Arroyo de la Cruz Creek	3	35.70833	121.30035	CCG	Riverine Low
310-SSU	Upper San Simeon creek	3	35.60921	121.07393	CCG	Riverine Low
310-SSC	Lower San Simeon creek	3	35.59448	120.12112	CCG	Riverine Low
CA02-0031	Chorro Creek, marina	3	35.34553	120.83629	CCG	Estuarine
CA02-0021	Chorro Creek, flats	3	35.34430	120.83168	CCG	Estuarine
CA02-0002	Los Osos creek	3	35.33418	120.83638	CCG	Estuarine
Ref. 12	Coon Creek	3	35.25498	120.88692	UCLA	Riverine Low
310-COO	Coon creek	3	35.25476	120.88549	CCG	Riverine Low
Ref. 1	Pismo Beach Ecological Reserve	3	35.13359	120.62396	UCLA	Lacustrine
Ref. 15	Sedwick Reserve	3	34.73013	120.02692	UCLA	Depressional
Ref. 13	Sedwick Reserve	3	34.72113	120.03613	UCLA	Riverine Low
Ref. 14	Sedwick Reserve	3	34.68298	120.04469	UCLA	Vernal Pool
Ref. 2	Los Padres National Forest	4	34.51467	119.26867	UCLA	Riverine Low
Ref. 20	Arroyo Hondo Canyon	3	34.48702	120.14222	UCLA	Riverine Low
Ref. 21	El Capitan Canyon	3	34.48049	120.01888	UCLA	Riverine High
Ref. 18	Santa Paula Creek	4	34.44172	119.07551	UCLA	Riverine Low
Ref. 11	Upper Santa Clara River	4	34.44020	118.31349	UCLA	Riverine Low
Ref. 7	City Creek Rte 330	8	34.17385	117.18515	UCLA	Riverine High
Ref. 19	Solstice Canyon.	4	34.03935	118.75321	UCLA	Riverine Low
Ref. 8	Upper Santa Margarita River	9	33.40826	117.23828	UCLA	Riverine Low
Ref. 6	Cibola Lake (NWR)	7	33.22461	114.67300	UCLA	Lacustrine

* CCG = Central Coast Group

Table 2. Jurisdictional habitat hierarchy.

Every mitigation site was apportioned into its component habitat types according to this hierarchy. First, the evaluator determined which proportion of the sites consisted of "waters" and which proportion was outside of "waters" (e.g., 60:40). Next, the wetland and non-wetland "waters" percentages would be determined (e.g., 50:10), as would any non-"waters" riparian and upland habitats (e.g., 20:20), and so forth. The sum of the equivalent habitat percentages would equal the above percentage in the hierarchy. These percentages were multiplied by the overall site acreage to determine the individual jurisdictional habitat acreages.

Waters of the United States			
	Wetland		
	Non-Wetland Waters		
		Non-Streambed Open Water	
		Streambed	
			Open Water Stream
			Unvegetated Streambed
			Vegetated Streambed
		Riparian Waters	
Non-Specified Riparian			
Non-waters of the United States			
	Non-waters Riparian		
	Upland		

Table 3. Overall summary of the permit file selection results by region.

This table includes the 429 permit files that were randomly selected from the SWRCB database, and pursued at either the Corps or Regional Board offices, or both. Two files were initially pursued, but later excluded because they had 401 permits that were issued directly by the State Board (SB).

Region	Pursued for review	Not located	Removed during review	Removed after field visit	Not visited or assessed	Assessed for compliance only	Assessed fully
1	32	15	5	0	1	2	9
2	75	29	20	0	0	1	25
3	43	16	4	7	1	2	13
4	44	6	10	9	0	4	15
5F	18	10	0	2	0	2	4
5R	27	17	2	0	2	0	6
5S	54	13	10	2	4	1	24
6T	23	14	4	1	2	0	2
6V	10	4	2	2	0	0	2
7	11	7	1	0	0	1	2
8	25	7	3	2	0	0	13
9	65	33	12	5	0	1	14
SB	2	1	1	0	0	0	0
Total	**429**	**172**	**74**	**30**	**10**	**14**	**129**

Table 4. Number of onsite and offsite mitigation sites for file specific mitigation actions, formal mitigation banks, informal mitigation banks, and in lieu fees.

	N	File-Specific	Formal Mitigation Bank	Informal Mitigation Bank	In-Lieu Fee
On Site Mitigation	127	125	1	1	0
Off Site Mitigation	77	29	31	14	3
Total	**204**	**154**	**32**	**15**	**3**

Table 5. Summary of the discrepancies between the impact and required mitigation acreage values obtained through our detailed permit reviews and the corresponding values in the State Board's permit tracking database. Multiple discrepancy categories may apply to a particular file.

Source of Impact and/or Mitigation Acreage Discrepancy	Number of Files	% of Total Files (N=143)
Discrepancy due to minor rounding issues in 401 permit or in SWRCB database	9	6.2
Data entry issue in SWRCB database (typographical error or misinterpretation of information in 401 permit, often due to ambiguous wording).	26	18.2
Issues with the 401 permit itself, including transcriptional and typographical errors, misinterpretations, or a lack of critical information in the 401 permit text	24	16.8
Discrepancy due to accounting difference (e.g., permanent vs. temporary impacts, or wetlands vs. non-wetland "waters") between reported values and 401 permit	27	18.9
Other agency required more mitigation than RB, but 401 permit not outdated	19	13.4
Mitigation planning modified after 401 permit issuance, permit outdated	12	8.4
Impacts reduced after 401 issuance, mitigation same, 401 permit outdated	3	2.1
Impacts reduced after 401 issuance, mitigation different, 401 permit outdated	13	9.1
401 outdated, impacts greater than 401 approved, mitigation same or different	12	8.4
Revised 401 permit entered separately into SWRCB database resulting in multiple entries and redundant acreage values	7	5.0
Summaries		
Discrepancies between reported values and the SWRCB database	101	70.6
Discrepancies between our reported values and the 401 permits themselves	86	60.1
Regulatory/compliance issues with files from an acreage perspective	60	42.0

Table 6. Summary of compliance scores based on 401 and mitigation plan evaluations including average scores and scores for the percentage of conditions met to 100% satisfaction.

Successful included files with compliance scores greater than 75%, partially successful included files with scores between 25% and 75%, and failure included files with scores less than 25%.

	N	Score	Successful	Partially Successful	Failure
Average 401	124	84.3%	76%	20%	4%
Average 401 percent-met		73.3%	57%	30%	13%
Average mitigation-plan	81	80.7%	68%	32%	0%
Average mitigation plan percent-met		67.6%	48%	35%	6%

Table 7. Compliance breakdowns for 401 and Mitigation Plan compliance grouped by compliance condition category (N=143 files). See Methods for details on condition categories. ND = not determinable.

Condition Code	Condition Category	401						Mitigation Plan					
		Total # Conditions	Average # Conditions	Average # ND	Average Score	Average % Met	Average % ND	Total # Conditions	Average # Conditions	Average # ND	Average Score	Average % Met	Average % ND
1	Third Party	58	1.5	0.1	99.3	99.3	8.8	26	1.6	0.1	90.0	90.0	6.3
2	Acreage	158	1.8	0.2	81.5	64.4	6.9	132	2.0	0.2	83.0	66.8	9.5
3	Site Implementation	411	6.0	2.7	84.8	71.9	45.1	546	7.9	3.1	84.3	72.4	40.4
4	Site Maintenance	49	1.6	0.8	76.0	56.7	45.6	93	2.2	0.7	80.7	68.1	34.3
5	Site Protection	66	1.5	0.6	81.3	72.6	42.5	58	1.6	0.4	77.9	72.4	25.6
6	Success & Performance Standards	199	3.9	1.5	76.4	49.7	31.0	298	4.4	1.3	76.0	52.9	26.3
7	Monitoring & Submission	254	3.6	2.0	59.5	52.3	54.3	220	3.2	1.4	60.9	53.7	45.7
8	Invocation of Other Agency Permits	126	1.7	1.1	N/A	N/A	69.3	5	2.5	1.0	N/A	N/A	100
9	Other	35	1.3	0.6	96.1	94.4	46.8	13	1.3	0.3	93.8	93.8	20.0
3 - 6	Site Implementation, Maintenance, Protection, Success/Performance Standards	725	3.2	1.4	79.6	62.7	41.0	995	4.0	1.4	79.7	66.4	31.6

Table 8. Summary statistics of mitigation CRAM mitigation site scores (N=129) and reference site CRAM scores (N=47) for Total-CRAM scores and the four attributes, along with the percentage of files within each success category.

	Reference Sites		File-wide CRAM Scores				
	Median	Mean ± SE	Median	Mean ± SE	Optimal	Sub Optimal	Marginal to Poor
Overall	82.06	79.13 ± 1.36	60.77	58.61 ± 1.10	19.38	56.59	24.03
Landscape Context	90.28	87.10 ± 1.06	72.32	65.57 ± 1.78	47.29	24.81	27.91
Hydrology	90.74	86.67 ± 1.58	62.96	62.67 ± 1.64	27.13	42.64	30.23
Physical Structure	79.17	76.06 ± 2.48	52.79	53.81 ± 1.61	49.61	27.13	23.26
Biotic Structure	68.33	66.68 ± 2.24	51.78	52.63 ± 1.28	62.02	25.58	12.40

Table 9. Summary statistics and success breakdowns of Total-CRAM scores by SWRCB region (N=129 files).

Total-CRAM Scores (Overall File-wide CRAM Scores)						
Region	N	Mean ± SE	Median	% Optimal	% Sub-Optimal	% Marginal / Poor
1	9	57.12 ± 4.76	50.93	22.22	55.56	22.22
2	25	51.08 ± 2.07	48.40	4.00	44.00	52.00
3	13	55.61 ± 3.81	58.74	15.38	61.54	23.08
4	15	57.67 ± 3.40	57.99	20.00	46.67	33.33
5F	4	61.73 ± 5.26	64.86	25.00	50.00	25.00
5R	6	61.57 ± 2.98	61.33	16.67	83.33	0.00
5S	24	64.40 ± 1.43	64.33	16.67	79.17	4.17
6T	2	74.43 ± 3.83	74.43	100.00	0.00	0.00
6V	2	42.52 ± 14.4	42.52	0.00	50.00	50.00
7	2	56.22 ± 8.17	56.22	0.00	50.00	50.00
8	13	64.25 ± 2.79	67.50	23.08	69.23	7.69
9	14	60.44 ± 4.38	65.63	42.86	35.71	21.43

Table 10. Summary statistics and success breakdowns of landscape context attribute CRAM scores by SWRCB region (N=129 files).

Landscape Context CRAM Scores						
Region	N	Mean ± SE	Median	% Optimal	% Sub-Optimal	% Marginal / Poor
1	9	55.43 ± 6.60	50.86	22.22	22.22	55.56
2	25	57.84 ± 3.80	57.33	28.00	32.00	40.00
3	13	57.52 ± 6.86	53.30	38.46	15.38	46.15
4	15	64.75 ± 3.79	64.25	33.33	40.00	26.67
5F	4	68.40 ± 14.20	81.78	75.00	0.00	25.00
5R	6	76.92 ± 2.90	74.91	66.67	33.33	0.00
5S	24	82.55 ± 1.95	86.65	83.33	16.67	0.00
6T	2	84.44 ± 3.70	84.44	100.00	0.00	0.00
6V	2	34.97 ± 9.30	34.97	0.00	0.00	100.00
7	2	81.83 ± 4.08	81.83	100.00	0.00	0.00
8	13	61.88 ± 5.64	62.69	38.46	30.77	30.77
9	14	62.29 ± 5.50	70.49	42.86	28.57	28.57

Table 11. Summary statistics and success breakdowns of hydrology attribute CRAM scores by SWRCB region (N=129 files).

Hydrology CRAM Scores						
Region	N	Mean ± SE	Median	% Optimal	% Sub-Optimal	% Marginal / Poor
1	9	65.90 ± 7.77	52.50	44.44	0.00	55.56
2	25	61.39 ± 3.84	58.71	28.00	40.00	32.00
3	13	58.20 ± 5.11	64.82	0.00	76.92	23.08
4	15	59.15 ± 4.66	54.63	20.00	40.00	40.00
5F	4	71.79 ± 9.11	74.58	50.00	25.00	25.00
5R	6	73.00 ± 4.66	72.87	50.00	50.00	0.00
5S	24	62.65 ± 4.15	65.16	29.17	37.50	33.33
6T	2	81.20 ± 1.20	81.20	100.00	0.00	0.00
6V	2	35.51 ± 16.3	35.51	0.00	0.00	100.00
7	2	63.75 ± 27.90	63.75	50.00	0.00	50.00
8	13	63.58 ± 4.37	60.83	30.77	38.46	30.77
9	14	64.04 ± 3.79	64.27	14.29	78.57	7.14

Table 12. Summary statistics and success breakdowns of physical structure attribute CRAM scores by SWRCB region (N=129 files).

Physical Structure CRAM Scores						
Region	N	Mean ± SE	Median	Optimal	% Sub-Optimal	% Marginal / Poor
1	9	52.90 ± 4.95	50.00	44.44	33.33	22.22
2	25	40.44 ± 3.52	39.83	24.00	28.00	48.00
3	13	55.55 ± 4.81	58.33	61.54	15.38	23.08
4	15	58.87 ± 5.29	66.67	60.00	26.67	13.33
5F	4	47.18 ± 7.58	45.42	25.00	50.00	25.00
5R	6	50.90 ± 5.32	47.23	33.33	50.00	16.67
5S	24	55.17 ± 2.68	59.56	58.33	25.00	16.67
6T	2	68.75 ± 18.8	68.75	50.00	50.00	0.00
6V	2	52.08 ± 2.08	52.08	50.00	50.00	0.00
7	2	50.69 ± 0.69	50.69	0.00	100.00	0.00
8	13	67.40 ± 3.73	70.83	76.92	23.08	0.00
9	14	57.99 ± 6.49	65.98	57.14	7.14	35.71

Table 13. Summary statistics and success breakdowns of biotic structure attribute CRAM scores by SWRCB region (N=129 files).

Biotic Structure CRAM Scores						
Region	N	Mean ± SE	Median	Optimal	% Sub-Optimal	% Marginal / Poor
1	9	54.24 ± 4.91	54.85	66.67	22.22	11.11
2	25	44.66 ± 2.36	45.00	40.00	36.00	24.00
3	13	51.18 ± 3.39	48.33	61.54	23.08	15.38
4	15	47.89 ± 2.82	45.23	40.00	53.33	6.67
5F	4	59.57 ± 5.32	60.07	75.00	25.00	0.00
5R	6	45.46 ± 4.29	44.55	50.00	33.33	16.67
5S	24	57.23 ± 1.89	60.07	83.33	16.67	0.00
6T	2	63.33 ± 8.33	63.33	100.00	0.00	0.00
6V	2	47.50 ± 30.00	47.50	50.00	0.00	50.00
7	2	28.61 ± 1.39	28.61	0.00	0.00	100.00
8	13	64.14 ± 3.53	65.00	84.62	15.38	0.00
9	14	57.43 ± 5.35	56.04	71.43	14.29	14.29

Table 14. Summary statistics and success breakdowns of CRAM scores by individual CRAM metric (N=204 mitigation sites).

Metric	N	Mean ± SE	Median
Buffer and Landscape Context			
Connectivity	204	68.2 ± 1.8	77.8
% of AA with Buffer	204	81.6 ± 1.4	91.7
Avg. Width of Buffer	204	61.9 ± 1.9	66.7
Buffer Condition	204	60.6 ± 1.4	66.7
Hydrology			
Water Source	204	59.5 ± 1.5	58.3
Hydroperiod	204	64.7 ± 2.0	73.3
Hydrologic Connectivity	117	64.6 ± 2.0	66.7
Physical Structure			
Physical Patch Richness	204	43.5 ± 1.8	41.7
Topographic Complexity	204	63.5 ± 1.4	66.7
Organic Matter Accumulation	204	69.3 ± 1.4	68.9
Biotic Structure			
Biotic Patch Richness	204	45.7 ± 1.4	41.7
Vertical Biotic Structure	190	39.1 ± 1.5	41.7
Interspersion / Zonation	204	58.6 ± 1.5	58.3
% Non-native Plant Species	204	60.5 ± 2.3	52.8
Native Plant Species Richness	204	49.3 ± 2.0	41.7

Table 15. Total impacted and obtained acreage for all files (overall), “waters of U.S.” and non “waters of U.S.,” wetland, and non wetland “waters.”

Overall acreage includes “waters of the U.S.” plus non-“waters” areas. The breakdown for wetlands/non-wetland “waters” does not include 5 permit files for which the jurisdictional impacts could not be distinguished.

	Total Impact	Total Obtained	Proportion Obtained	Net Acreage Gain	Gained /Loss Ratio
Overall Acreage	216.8	417.0	NA	200.2	1.9
Waters of U.S.	212.4	303.2	72.7	90.8	1.4
Non Waters of U.S.	4.4	113.8	27.3	109.4	NA
Waters of U.S.:					
Wetlands	121.2	180.5	63.2	59.3	1.5
Non Wetland Waters	74.5	105.2	36.8	30.7	1.4

Table 16. Permanent impacts and created mitigation acreage, “waters of U.S.” and non “waters of U.S.,” and wetland, non wetland “waters.”

	Permanent Impact	Created Acreage	Proportion Obtained	Net Acreage Gain	Gained /Loss Ratio
Overall Acreage	165.8	270.9	NA	105.1	1.6
Waters of U.S.	162.7	223.1	82.4	60.4	1.4
Non Waters of U.S.	3	47.8	17.6	44.8	NA
Waters of U.S.:					
Wetlands	106.3	146.7	66.4	40.4	1.4
Non Wetland Waters	54.9	74.2	33.6	19.3	1.4

Table 17. Total impacted and obtained acreage for all files (overall), "waters of U.S." and non "waters of U.S.," wetland, and non wetland "waters."

	% Files with Gains	% Files where Gained = Lost	% Files with Losses
Overall Acreage	64	17	20
Waters of U.S.	54	13	33
Non Waters of U.S.	45	55	0
Wetlands	58	19	22
Non Wetland Waters	24	34	42

Table 18. Permanent impacts and created mitigation acreage, "waters of U.S." and non "waters of U.S.," and wetland, non wetland "waters."

	% Files w/Gains	% Files Gained=Lost	% Files w/Loss
Overall Acreage	41	20	39
Waters of U.S.	36	17	47
Non Waters of U.S.	24	76	1
Wetlands	40	32	28
Non Wetland Waters	17	37	46

Table 19. Mitigation success by permit file for each evaluation category: acreage requirement, 401 conditions, mitigation plan conditions, and wetland condition.

Data shown for acreage and compliance are percentages out of a total number of 143 permit files. Wetland condition data are percentages of a total number of 129 files. Numbers in parentheses are the actual number of sites within each category. For the acreage requirements, success was considered 100 percent, partial success was considered 75 to 100 percent (lower and upper bounds not inclusive), and failure was 75 percent and below. For the 401 and MP compliance evaluation, success was considered 75 to 100 percent, partial success was considered 25 to 75 percent (lower and upper bounds not inclusive), and failure was 25 percent and below. For the CRAM evaluation of wetland condition, success was considered 70 to 100 percent, partial success was 50 to 70 percent (lower and upper bounds not inclusive), and failure was 50 percent and below.

Category	Percent Success (N)	Percent Partial Success (N)	Percent Failure (N)	Cannot Be Determined (N)
Acreage Requirement	72 (101)	11 (16)	17 (24)	(2)
401 Conditions	76 (94)	20 (25)	4 (5)	(19)
Mitigation Plan Conditions	68 (55)	32 (26)	0 (0)	(62)
Wetland Condition	19 (25)	55 (71)	26 (33)	Not a category

Table 20. Acreage, compliance, and CRAM summaries by permittee type. These permittee type categories were taken directly from the 401 permit files.

See text for methods used to derive the measures presented in this table.

	Developer	**Industry**	**Caltrans**	**Municipal**	**Private**	**State/Federal**
Number of Files	66	9	13	34	13	8
Average Impact Acreage (Total Impact Acreage)	1.17 (76.96)	1.73 (15.54)	2.35 (30.55)	1.75 (59.55)	0.63 (8.19)	3.26 (26.05)
Average Required Acreage for Mitigation (Total Required Acreage)	2.30 (151.80)	7.12 (64.11)	5.22 (67.80)	2.36 (80.30)	0.97 (12.65)	8.57 (68.59)
Average Obtained Acreage (Total Obtained Acreage)	2.15 (141.75)	6.44 (57.95)	4.79 (62.25)	2.28 (77.63)	0.83 (10.84)	8.33 (66.60)
Average Acreage Gained (Total Acreage Gained)	0.98 (64.80)	4.71 (42.41)	2.44 (31.71)	0.53 (18.08)	0.20 (2.66)	5.07 (40.55)
Average Mitigation Ratio (Required)	3.22:1	16.91:1	1.51:1	2.32:1	1.67:1	1.63:1
Average Mitigation Ratio (Obtained)	3.13:1	17.36:1	1.38:1	2.40:1	1.89:1	1.33:1
Average 401 Compliance Score	85.93	84.06	87.60	79.77	87.87	76.20
Average Mitigation Plan Compliance Score	81.70	89.96	73.94	80.56	76.98	79.20
Average Total-CRAM Score	57.42	56.71	61.24	59.81	58.03	63.53
Average CRAM-Adjusted Acreage (Total CRAM-Adjusted Acreage)	1.35 (81.18)	3.55 (31.91)	3.58 (35.79)	1.24 (38.38)	0.44 (4.82)	4.09 (32.71)

Table 21. Summary of administrative and regulatory recommendations.

	Improving mitigation requirements	Information management	Improve permit clarity	Assessment of “no net loss”	Coordination with other agencies
Permit conditions should ensure complete compensation for the full suite of wetland functions and services lost	X				
Ensure that mitigation projects compensate for losses in water quality (pollution) improvement services	X				
There should be a better accounting of the habitat types lost and gained	X				
Mitigation projects should have appropriate landscape context	X				
Offsite mitigation should be within the same catchment, or at least the same watershed	X				
Improvements to Database		X			
Improve permit archiving		X			
Improve tracking the progress of mitigation projects		X			
Important permit information should be clearly delineated in tables			X		
Permit conditions should be written so that the extent of efforts must match the intent of the condition to be in compliance			X		
Every mitigation plan and permit should include a table of requirements upon which compliance will be judged			X		
Permits should be clear about the meaning of enhancement, restoration and creation			X		
Performance standards should be clear about the goal of invasive species control			X		
Proof of inundation or saturation appropriate for wetland development should be required for mitigation wetlands			X		
Pre- and post-construction functional assessments of impact and mitigation sites should be required				X	
Improve incorporation of final permit information into Water Board files					X
Consider developing an integrated permit					X

Table 22. Suggested jurisdictional and non-jurisdictional habitat hierarchy, with structure for tracking losses and gains.

Impact/Mitigation Acreage Accounting	**Impacted**			**Required**				
	Total	Permanent	Temporary	Total	Creation	Restoration	Habitat Enhancement	Preservation
Waters of the United States.								
Wetland (Total)								
Riverine								
Estuarine/Lagoon								
Seasonal/Depressional								
Vernal Pool								
Seep/Spring/Wet Meadow								
Lacustrine Fringe								
Other								
Non-Wetland Waters								
Non-Streambed Open Water								
Streambed (Total)								
Open Water								
Unvegetated Streambed								
Vegetated Streambed								
Other (Ex: Riparian Waters)								
Non-waters of the United States.								
Non-federal Waters of the State								
Isolated Wetlands								
DFG Riparian (i.e., to “drip line”)								
Other Riparian (non-jurisdictional)								
Upland								

10.Figures

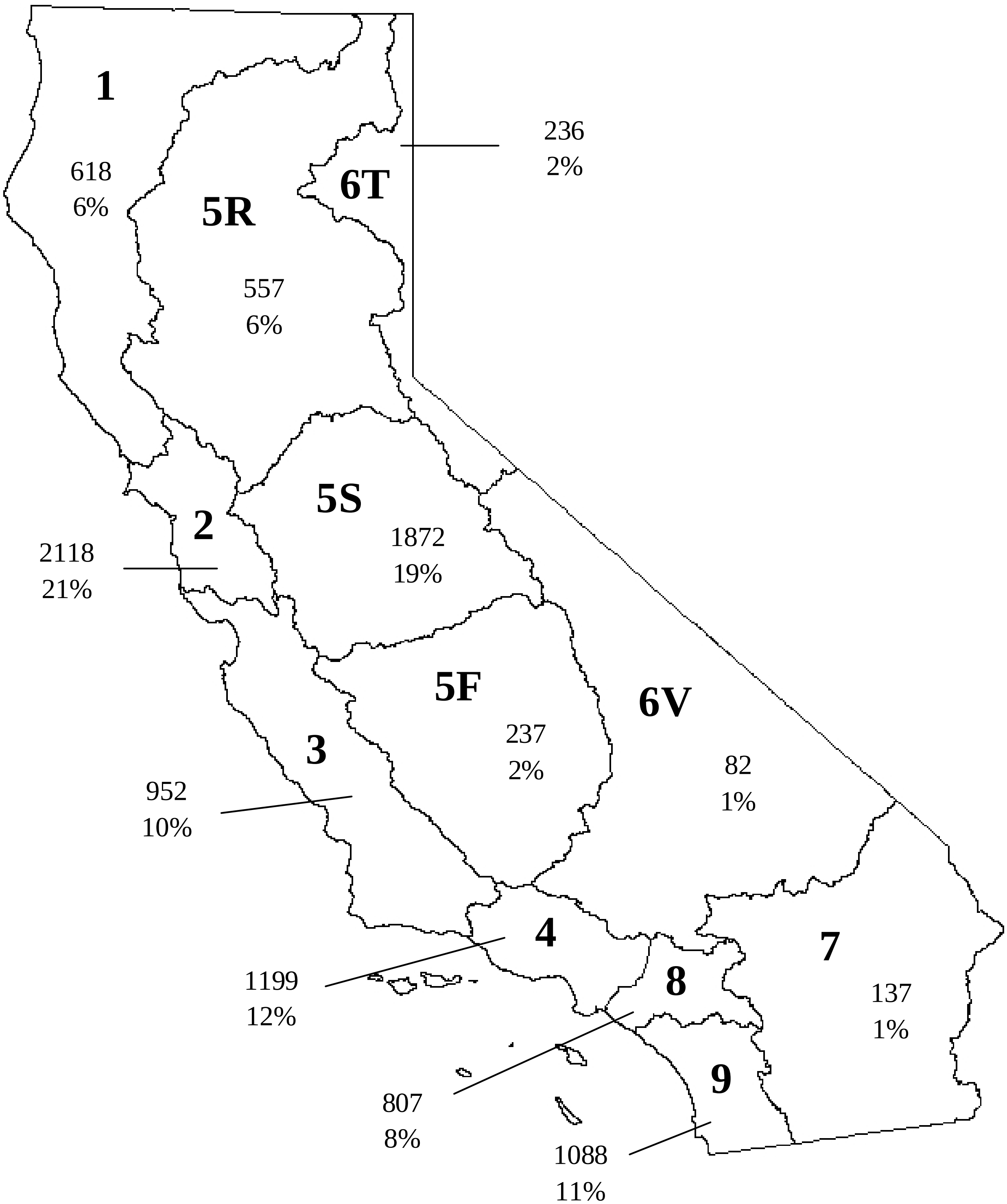

Figure 1. Map of California state board regions with breakdown of number of permit files.

The total number of files listed in the SWRCB database by region from 1991-2002 (N=9924 files) and the percentage of files by region of the total number of files in the SWRCB database from 1991-2002.

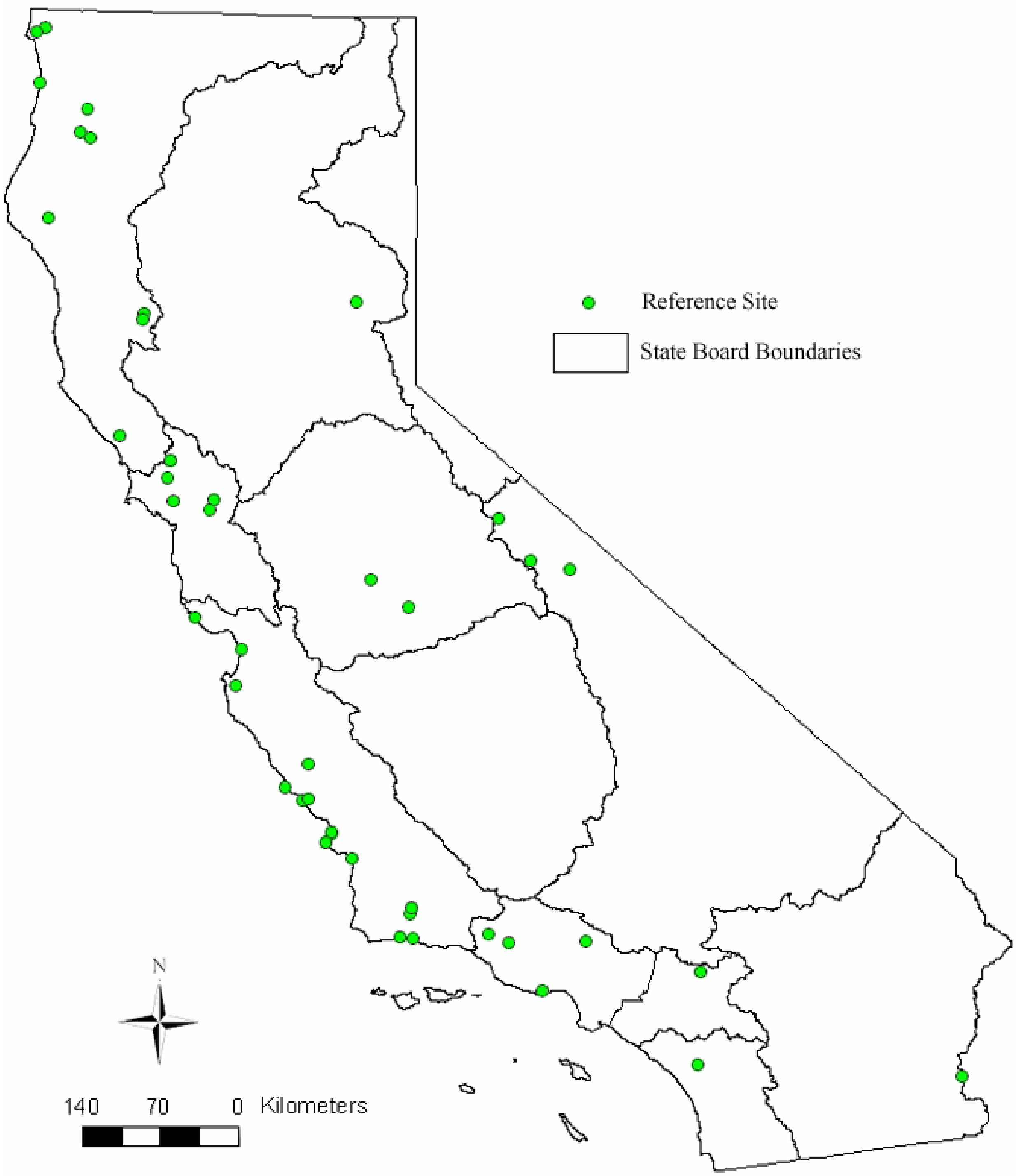

Figure 2. Statewide distribution of reference sites.

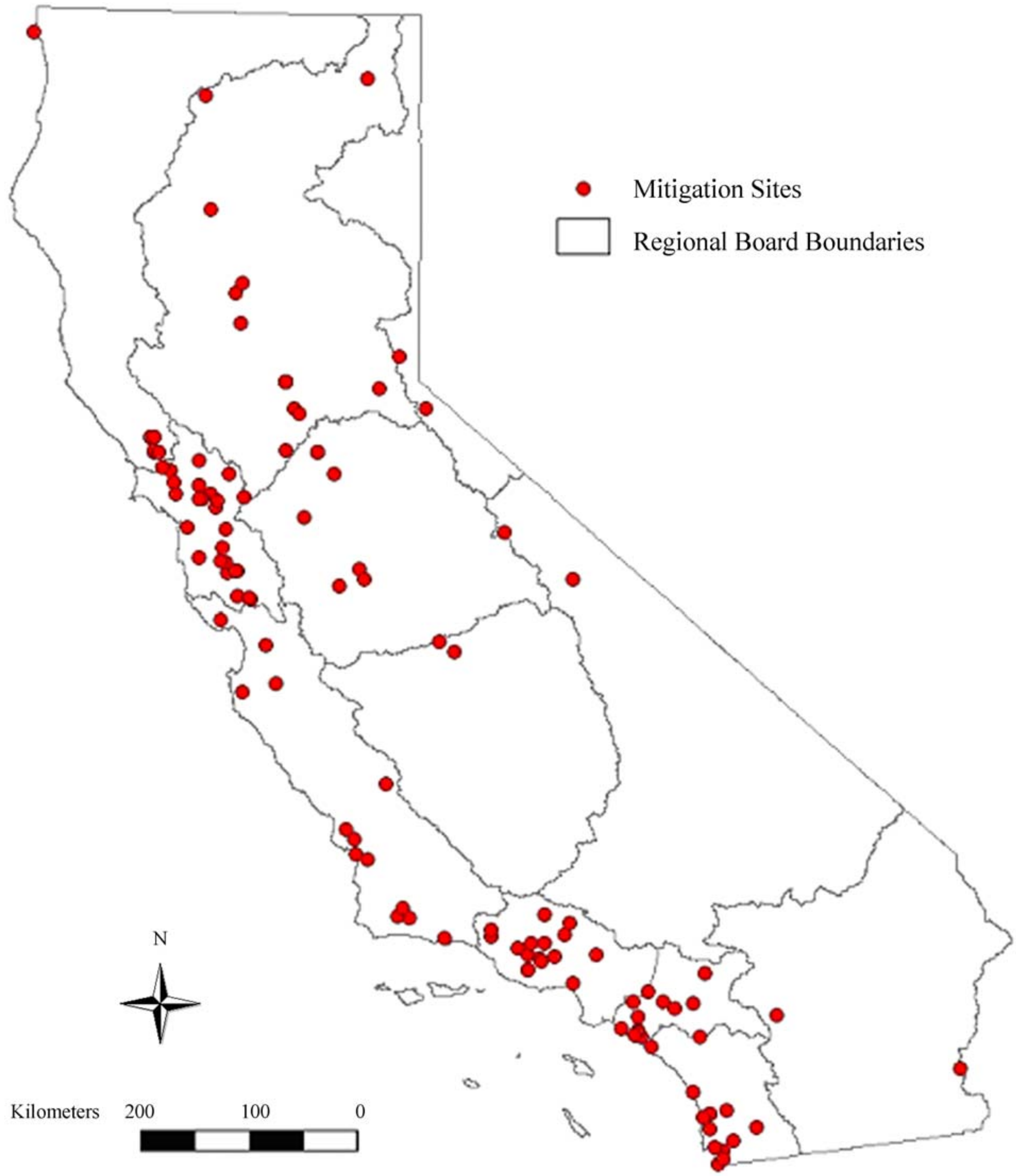

Figure 3. Statewide distribution of the assessed mitigation sites associated with the 143 permit files.

Several of these sites, especially those in the central valley (Region 5) involved a collection of shared mitigation banks which resulted in fewer than 143 mitigation sites. Points represent each assessed mitigation site rather than multiple sites per file.

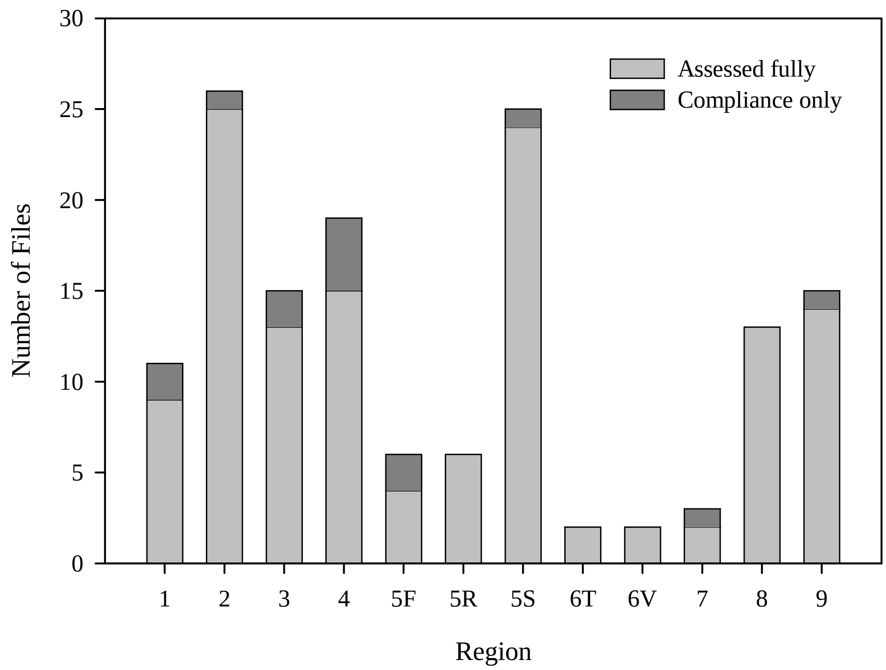

Figure 4. Files assessed fully and for compliance only by state board region.

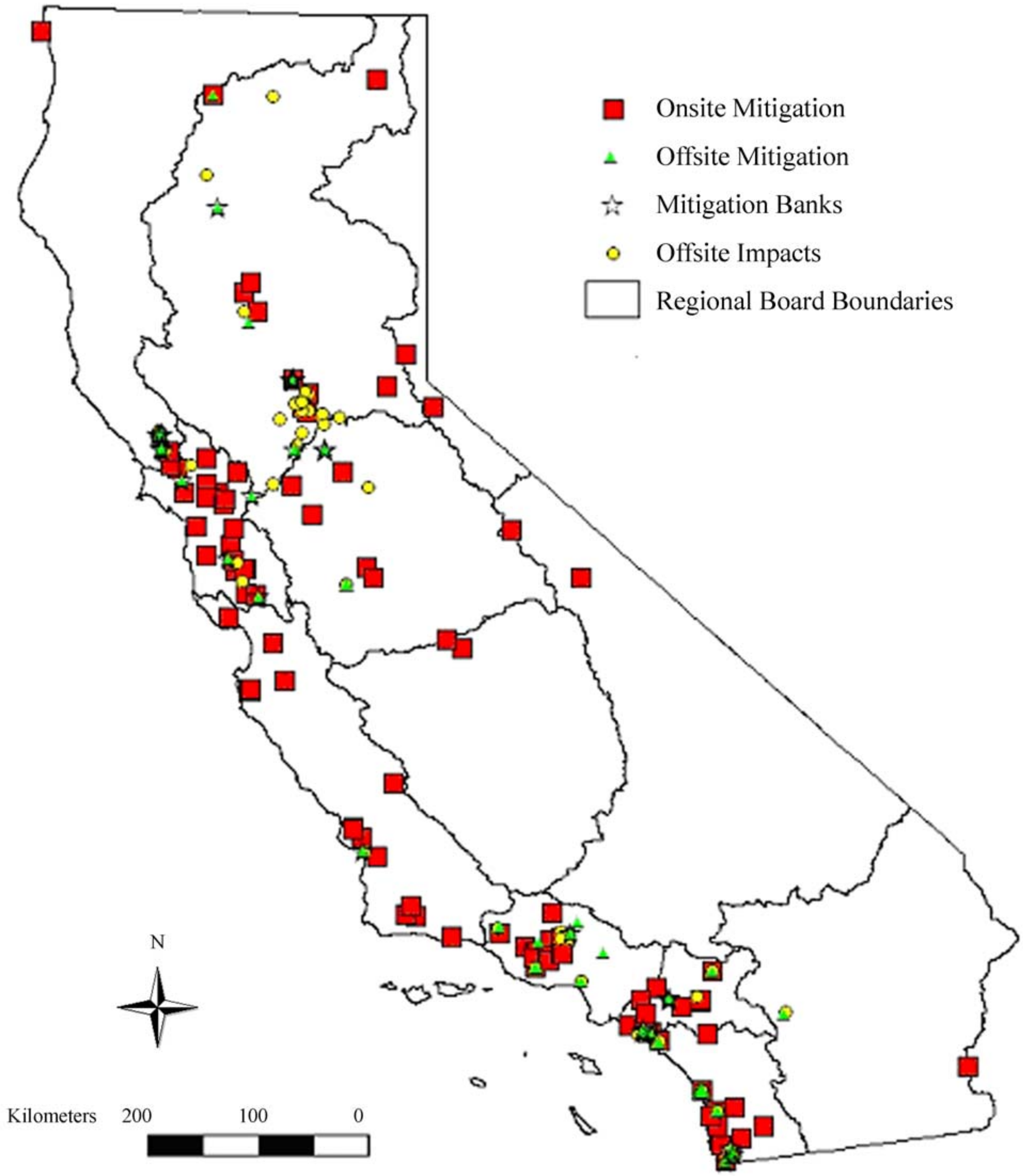

Figure 5. Statewide distribution of the impact and mitigation sites associated with the 143 permit files assessed.

Onsite Mitigation refers to files where impacts and mitigation occurred at the same location. Offsite Mitigation refers to location of a mitigation action that was not in the same location as an impact. Mitigation Banks refers to locations of mitigation banks, which also were not in the same location as an impact. Offsite Impacts indicate the location of an impact that was mitigated with an offsite mitigation action.

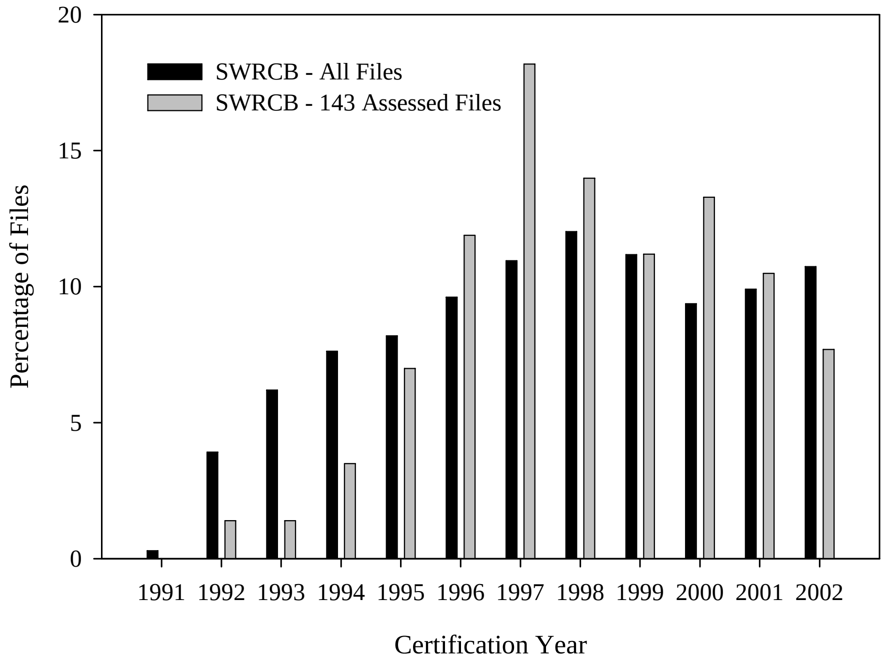

Figure 6. Percentage of applications per certification year listed in the SWRCB database from 1991 to 2002 compared with the percentage of files per year in our sample of files assessed fully and for compliance only (N for files assessed=143, N for SWRCB database=9924).

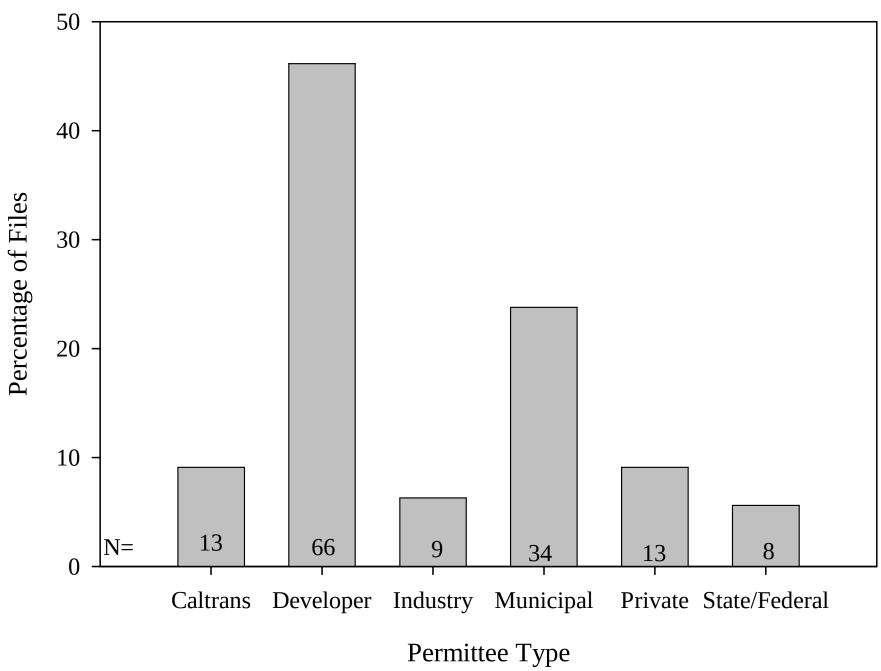

Figure 7. Percentage of files assessed by permittee type (N=143 files).

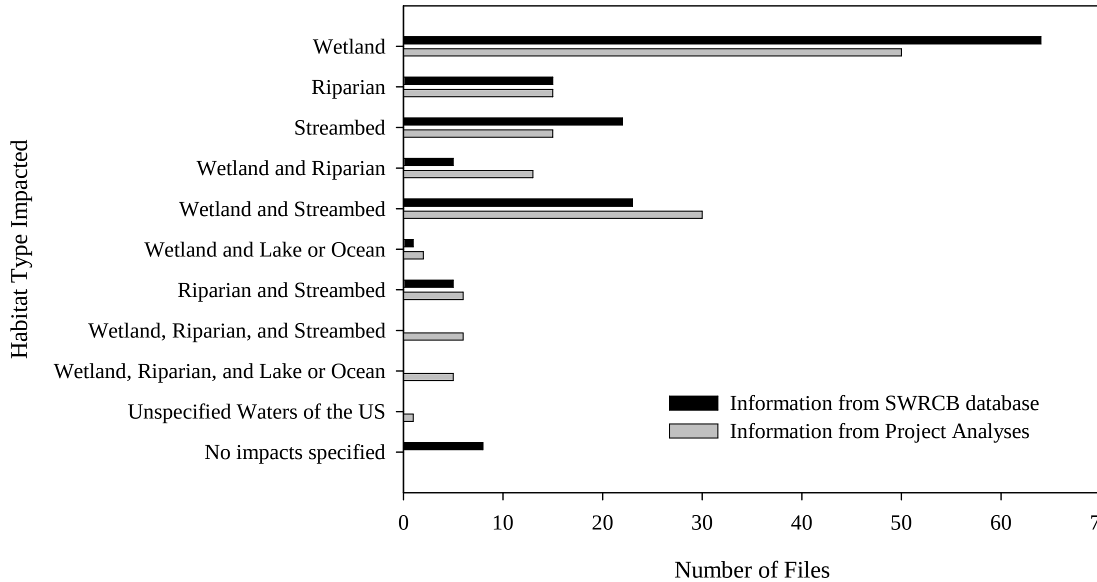

Figure 8. Breakdown of the 143 assessed files by habitat type impacted as reflected by the SWRCB database, and by our detailed permit reviews.

Some files had impacts to a single habitat type while others impacted multiple habitat types. The individual wetland types are not included here as such information is not consistently available in the SWRCB database.

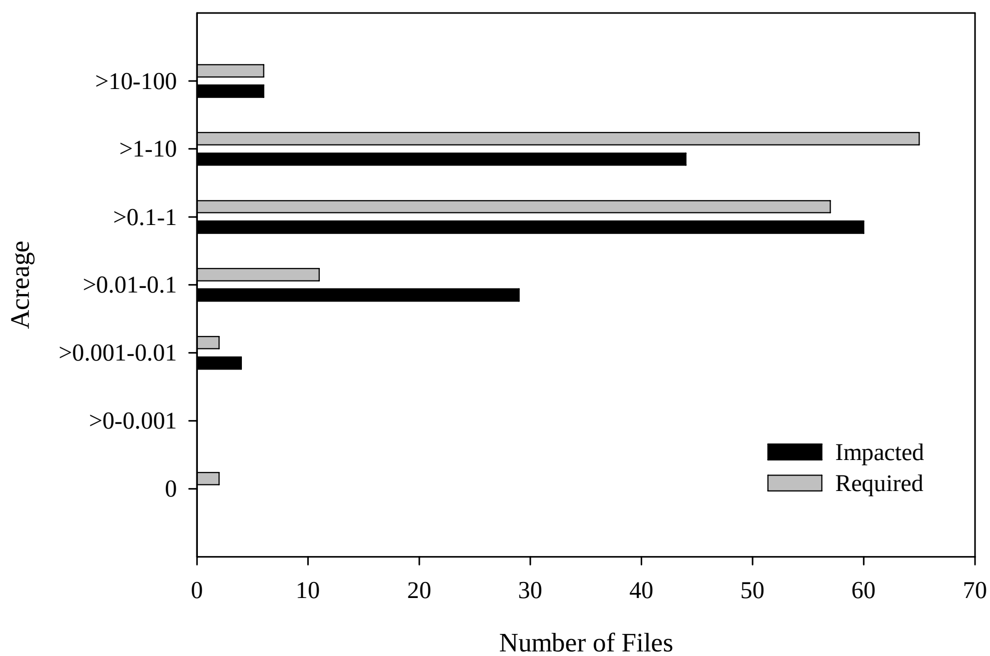

Figure 9. Acres impacted and acres of mitigation required displayed by acreage-size categories using data from project analyses for files assessed (N=143).

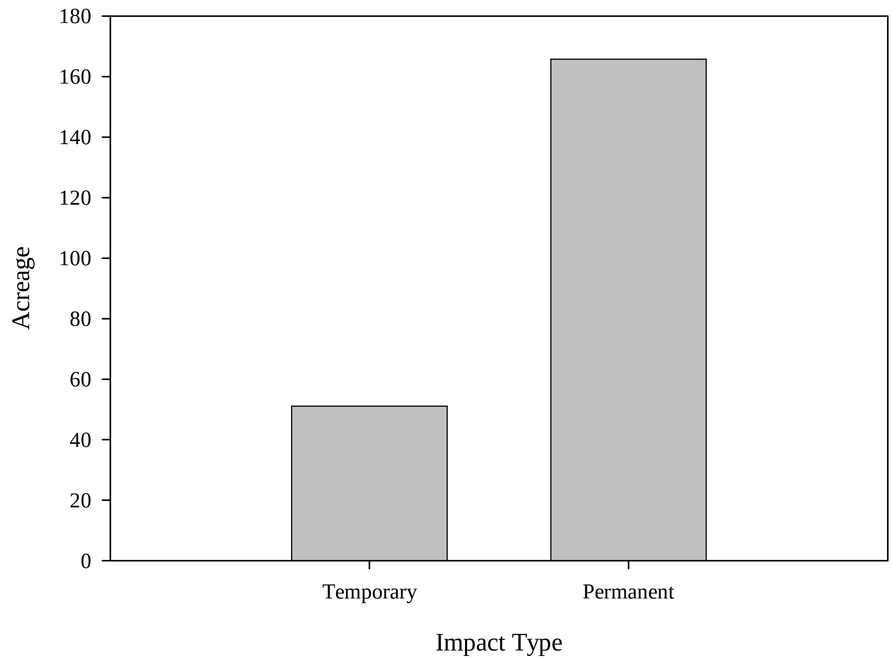

Figure 10. Breakdown of the 143 assessed permit files by permanent and temporary impacts as reflected by the SWRCB database, and by our detailed permit reviews.

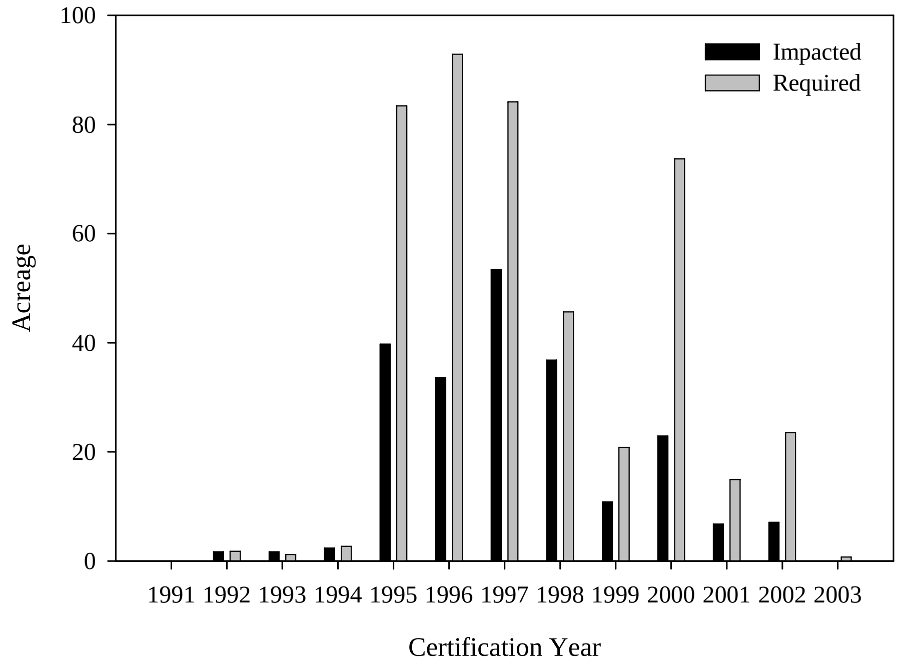

Figure 11. Acres impacted and acres of mitigation required displayed by certification year from the project analyses for files assessed (N=143).

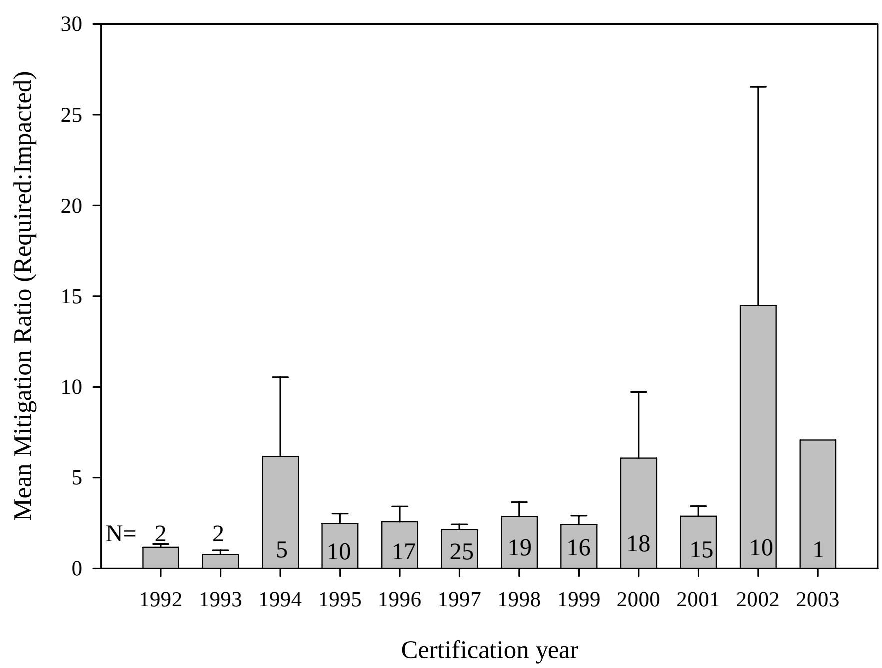

Figure 12. Average mitigation ratios required by certification year as determined from our detailed permit file review (N=143).

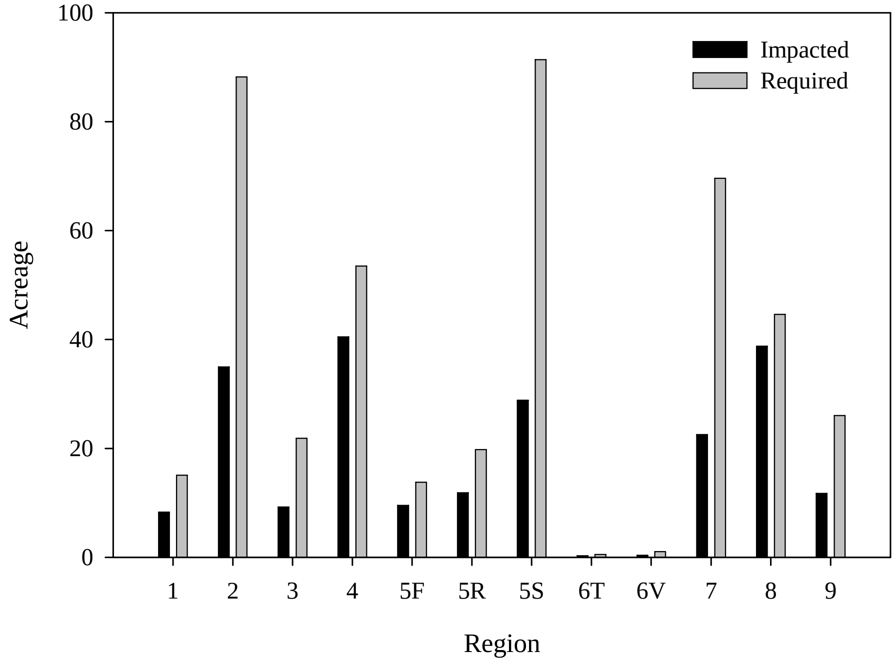

Figure 13. Acres impacted and acres of mitigation required displayed by state board region from the project analyses for files assessed (N=143).

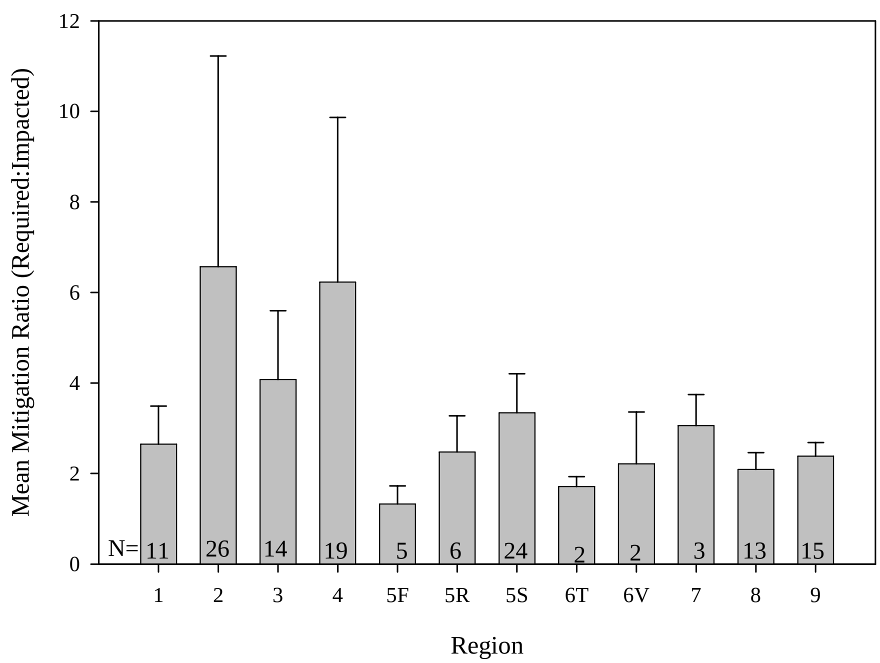

Figure 14. Mitigation ratios required by region (N=143).

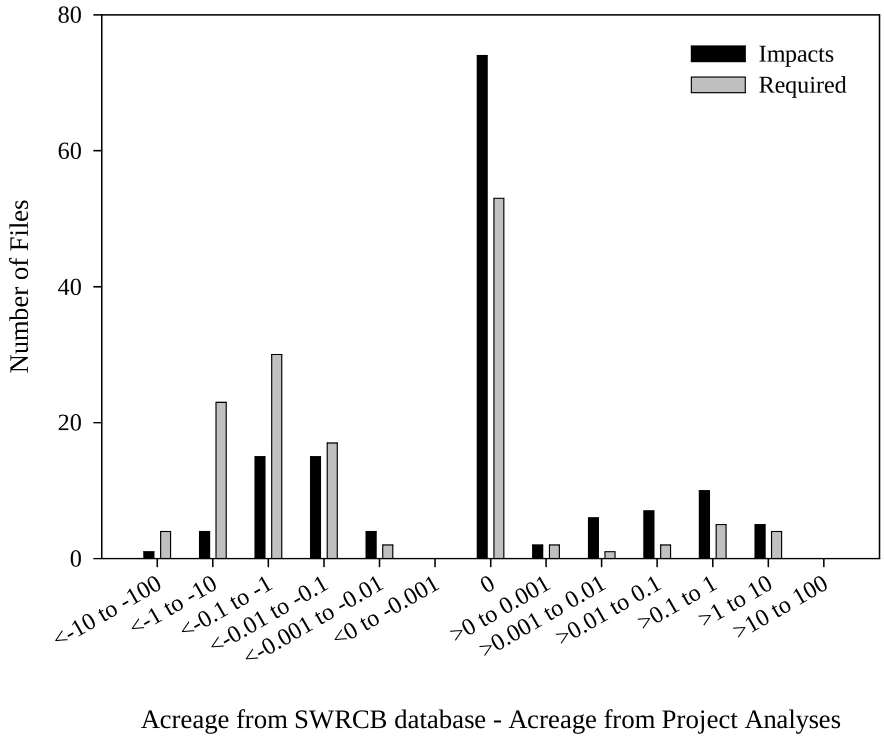

Figure 15. Plot of the differences between the impacted and required acreage values obtained through our detailed file review, and the corresponding values recorded in the SWRCB database.

A logarithmic scale was used for the data bins due to the wide range of acreage values involved. Negative values indicate that a lower value of acreage required was recorded in the SWRCB database compared to the acreage calculated during project analyses.

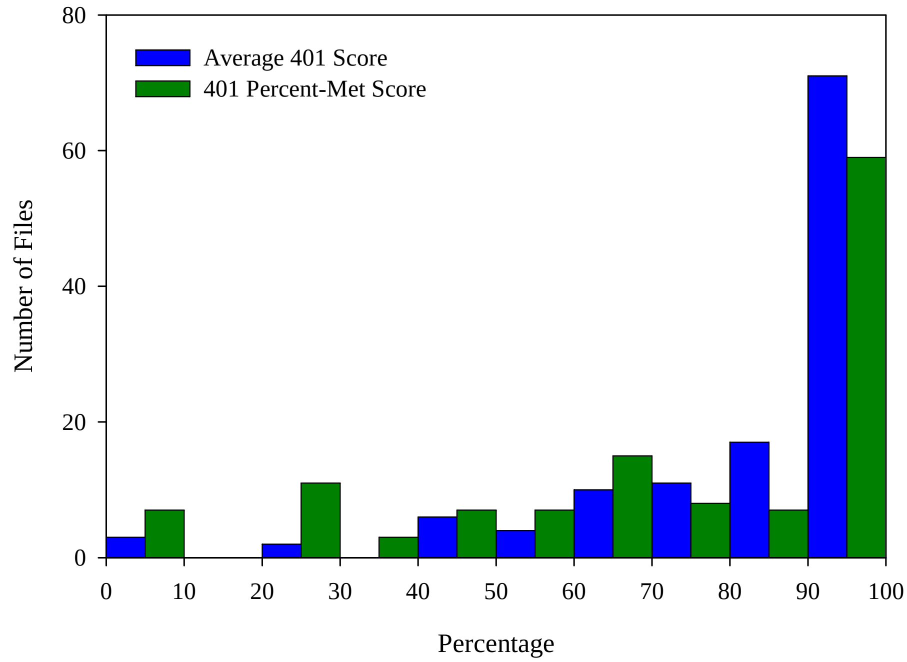

Figure 16. Distribution of files according to the average 401 permit compliance score and 401 percent-met score (N=124 files with assessable 401 permit conditions).

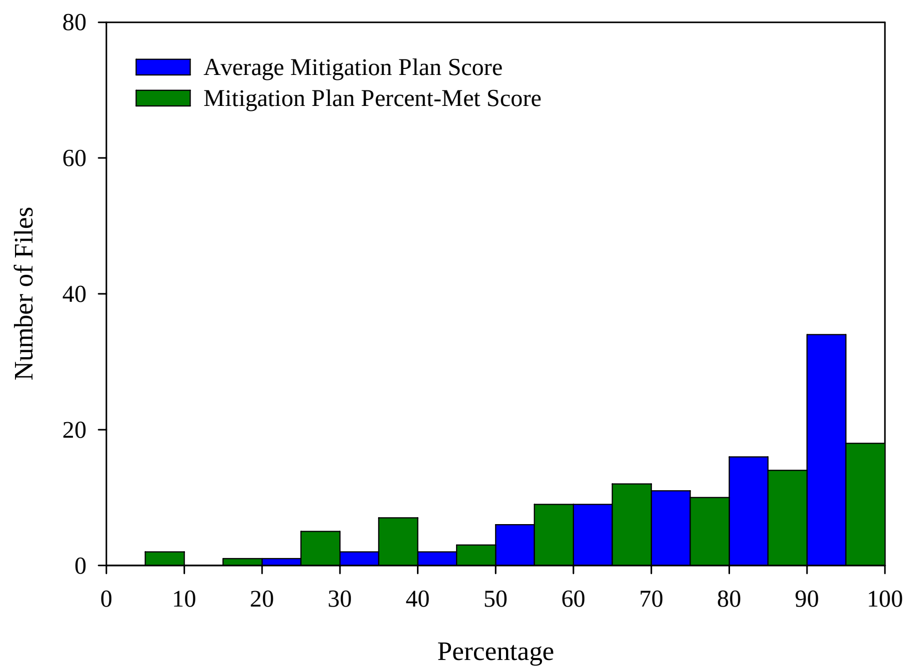

Figure 17. Distribution of files according to the average mitigation plan compliance score and mitigation plan percent-met score (N=81 files with assessable mitigation plan conditions).

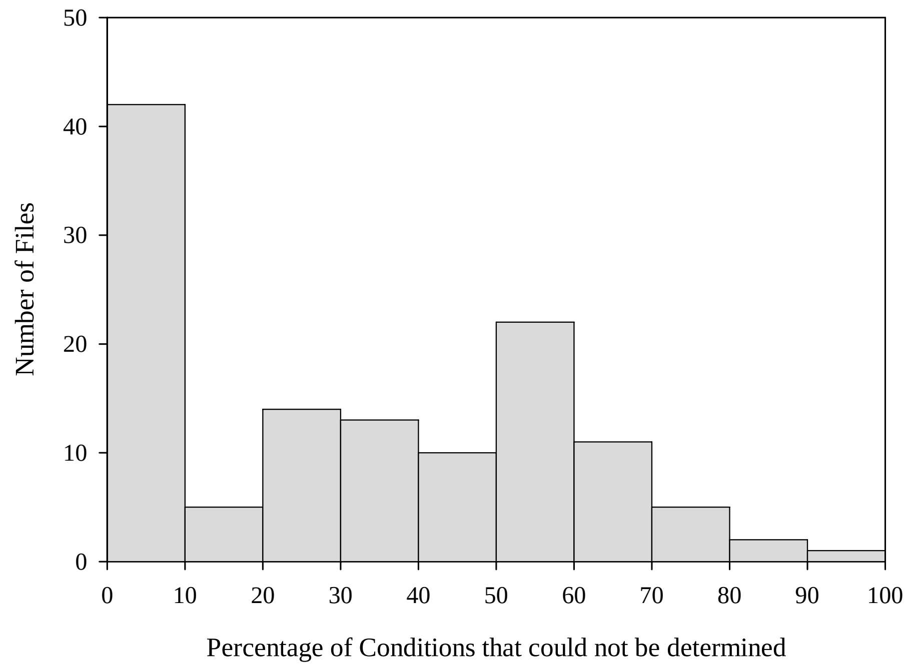

Figure 18. Distribution of files according to the percentage of 401 permit compliance conditions that could not be determined (N=124 files with assessable 401 permit conditions).

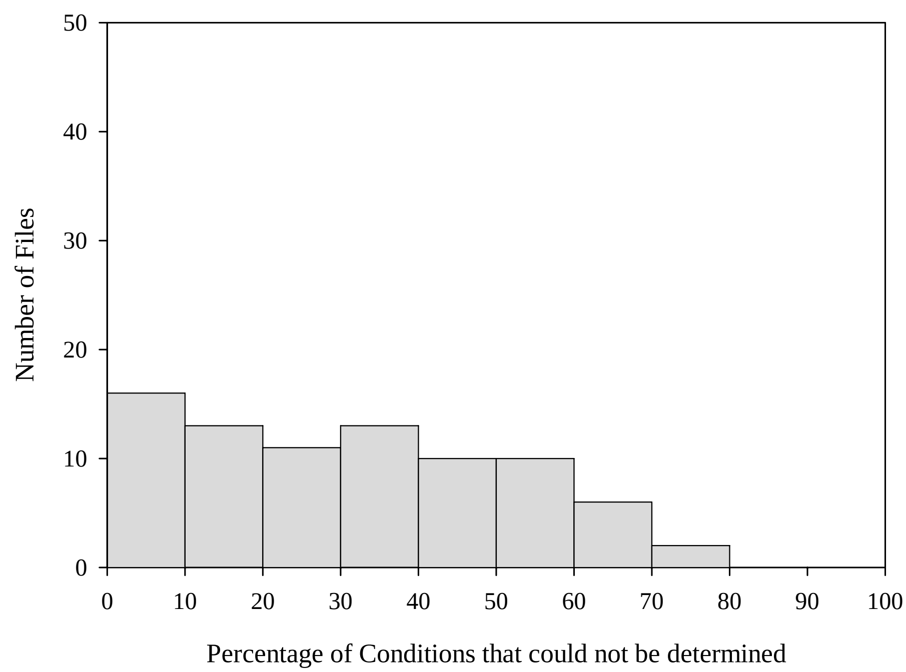

Figure 19. Distribution of files according to the percentage of mitigation plan compliance conditions that could not be determined (N=81 files with assessable mitigation plan conditions).

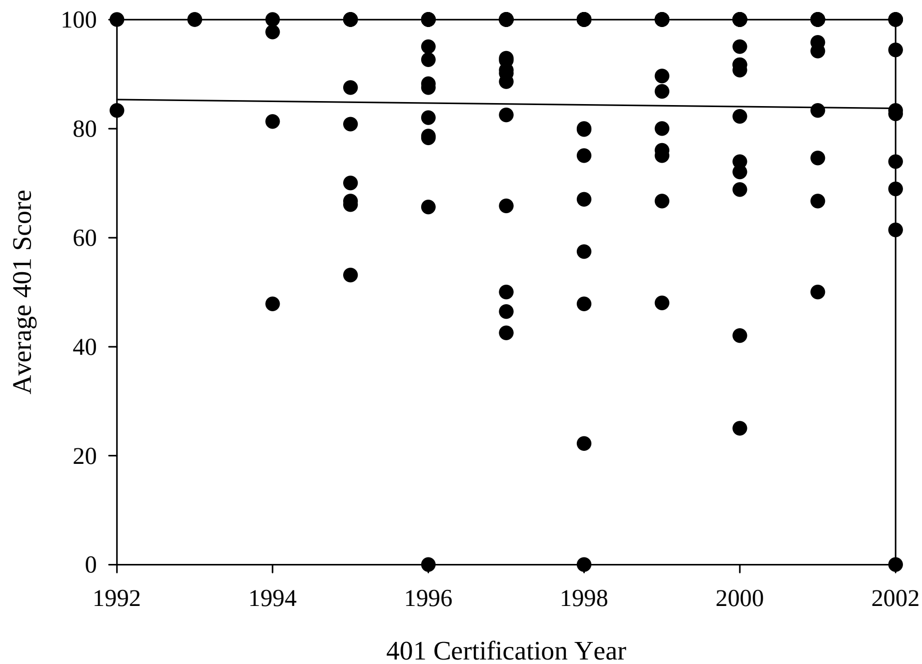

Figure 20. Relationship between 401 certification year and average 401 permit compliance score (N= 124 files with assessable 401 permit conditions; p=0.845, r^2=0.000).

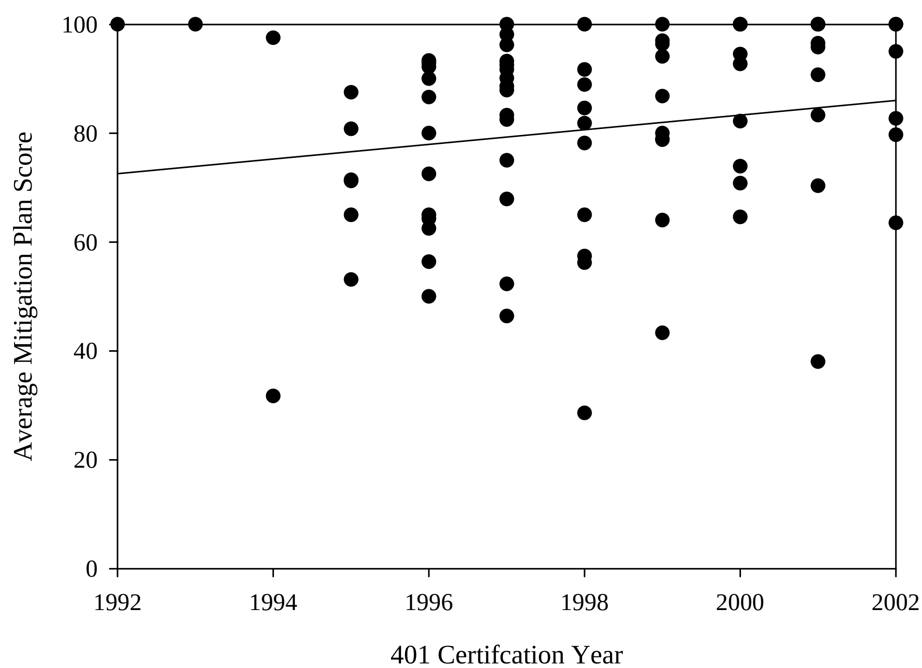

Figure 21. Relationship between 401 certification year and average mitigation plan compliance score (N= 81 files with assessable mitigation plan conditions; p=0.119, r^2=0.030).

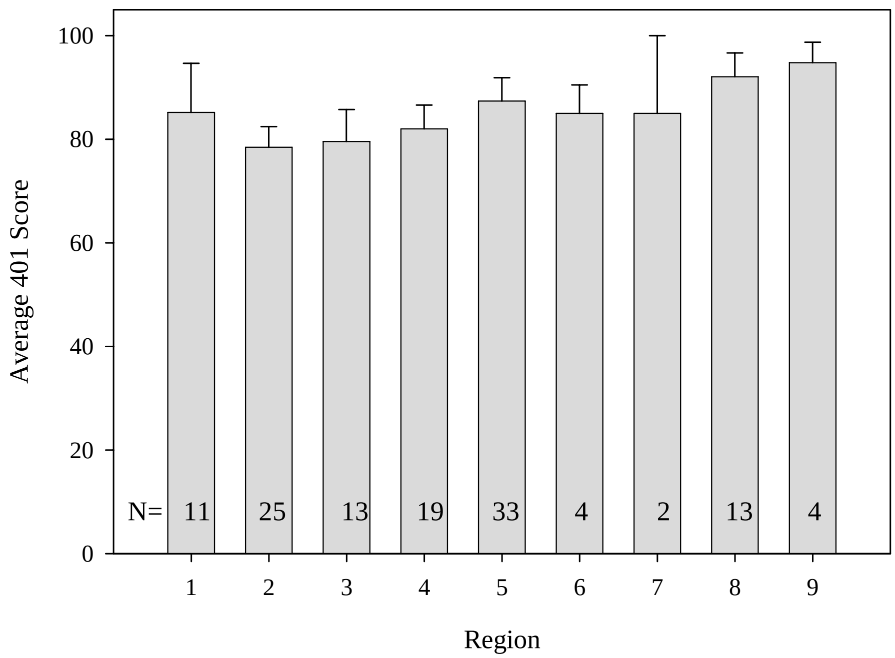

Figure 22. Average percentage score for 401 permit compliance by state board region (N=124 files with assessable 401 permit conditions).

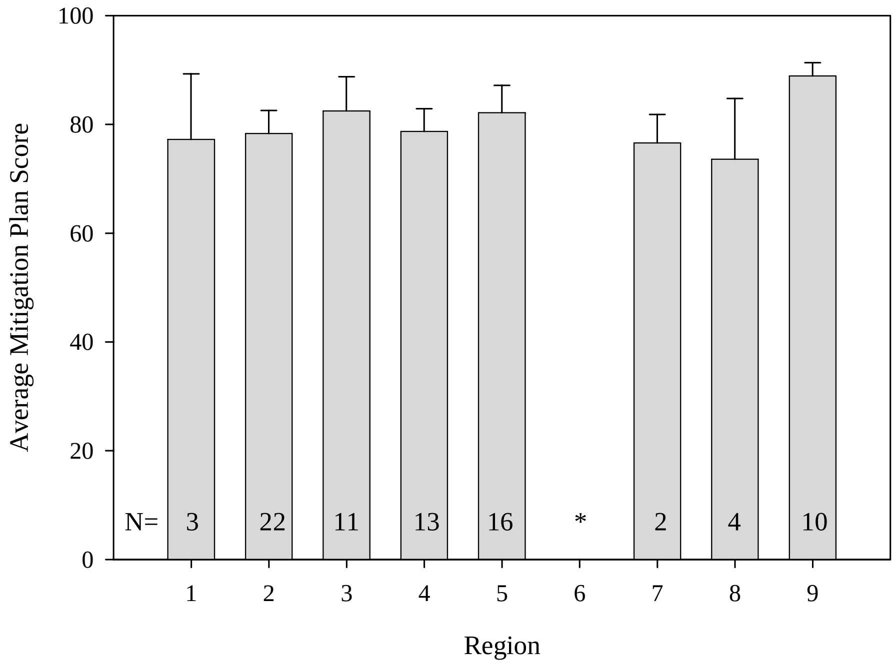

Figure 23. Average percentage score for mitigation plan compliance by state board region (N=81 files with assessable mitigation plan conditions).

*None of the four files from Region 6 included mitigation plans.

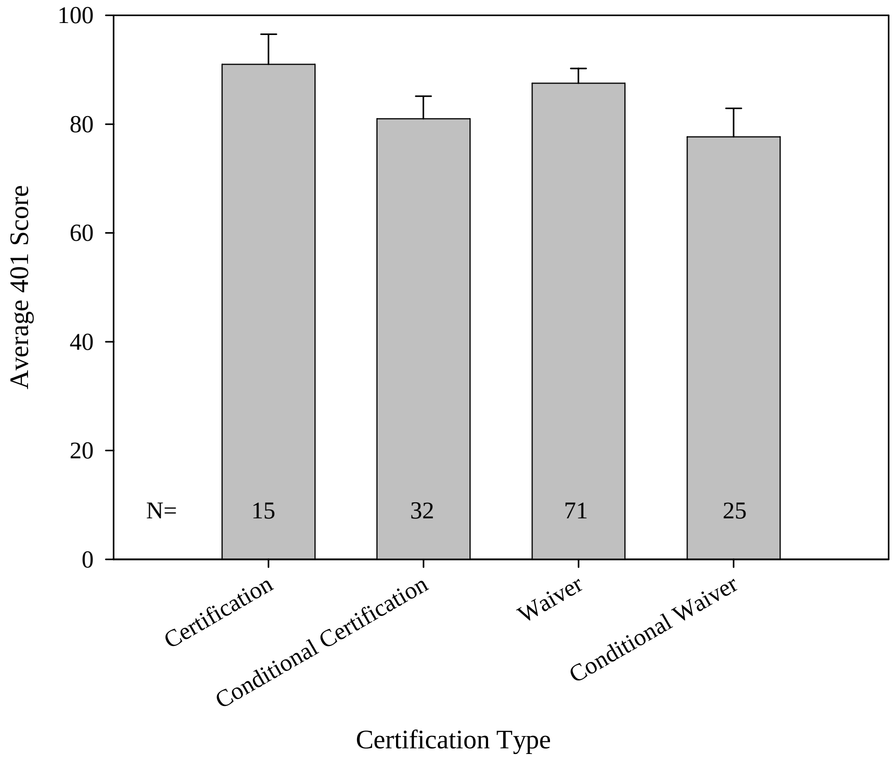

Figure 24. Average 401 score by certification type (N=143 files).

The categories used in this analysis correspond to the categories in the SWRCB database as follows: Certification=CERT, STDCERT, WDR; Conditional Certification=CONDCERT; Waiver=WAIVE, WDRWV; Conditional Waiver=CNDWV, WDRCNDWV. Several files were listed as certifications and as waivers of waste discharge requirements; these files were categorized as certifications for the purposes of this figure. File #0 was not listed in any of these categories in the SWRCB database, so we determined from the 401 permit that it was a certification and waiver of waste discharge requirements. Therefore, it is listed as a certification for this analysis.

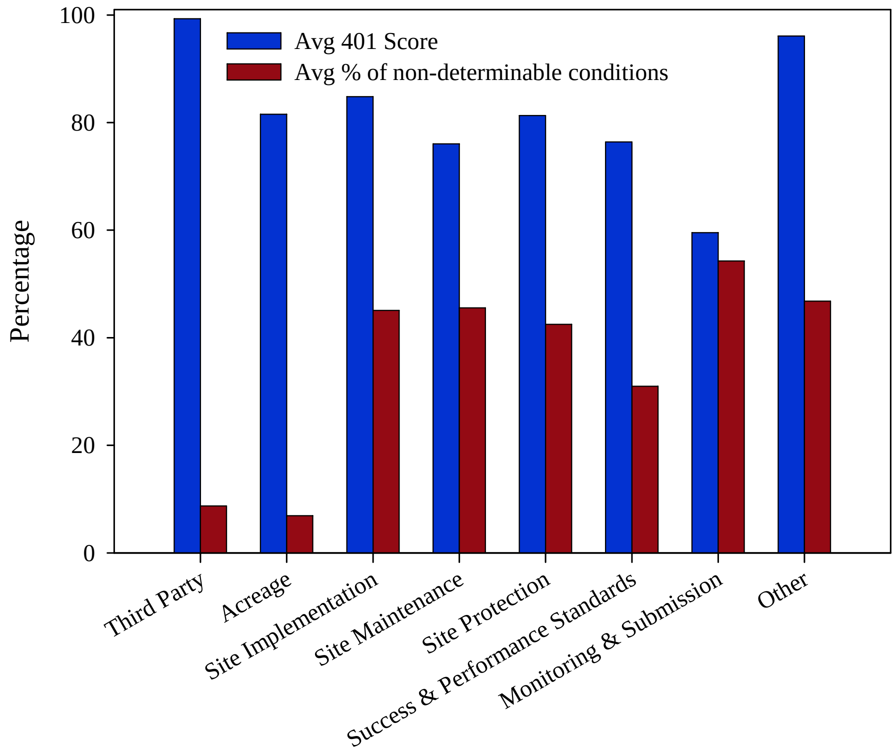

Figure 25. Average scores for 401 permit compliance and average percentage of conditions that could not be determined grouped by the type of permit condition (N=124 files with assessable 401 permit conditions).

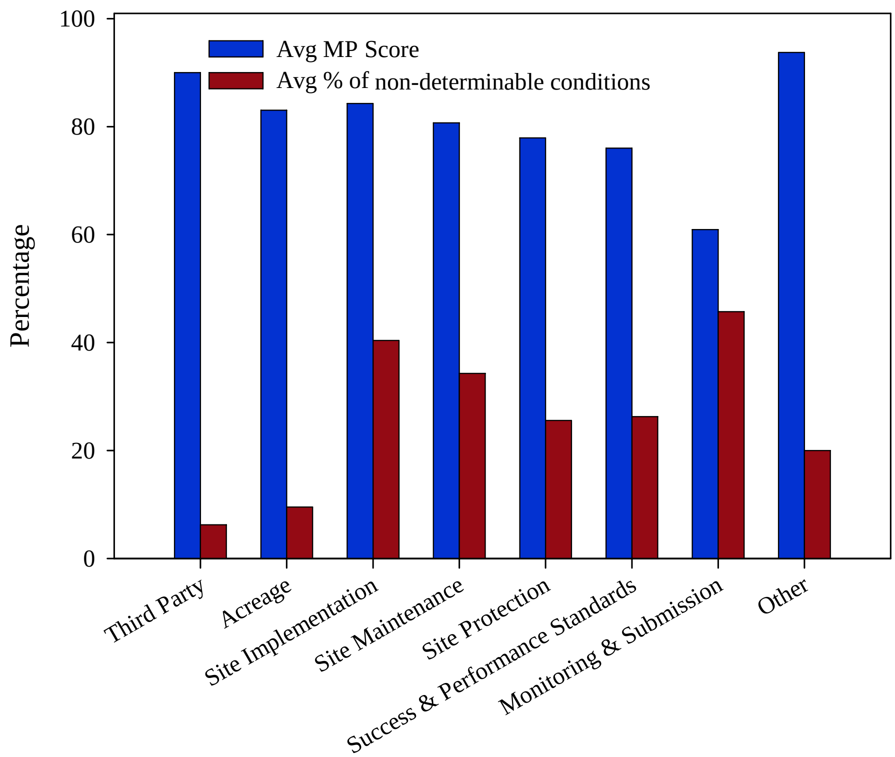

Figure 26. Average scores for mitigation plan compliance and average percentage of conditions that could not be determined grouped by the type of permit condition. (N = 81 files with assessable mitigation plan conditions).

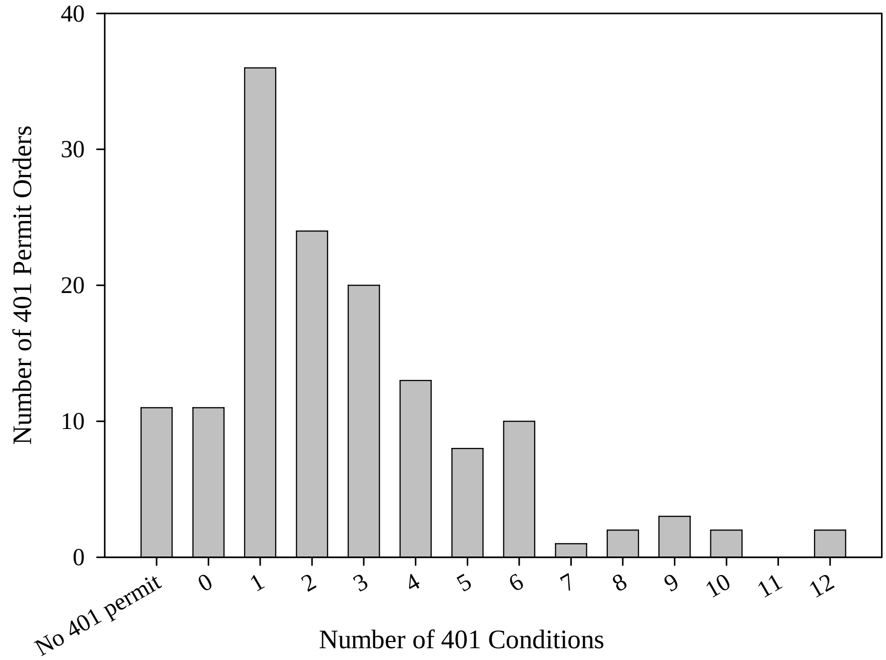

Figure 27. Breakdown of the number of mitigation-related permit requirements (conditions) in each 401 permit order (N=143).

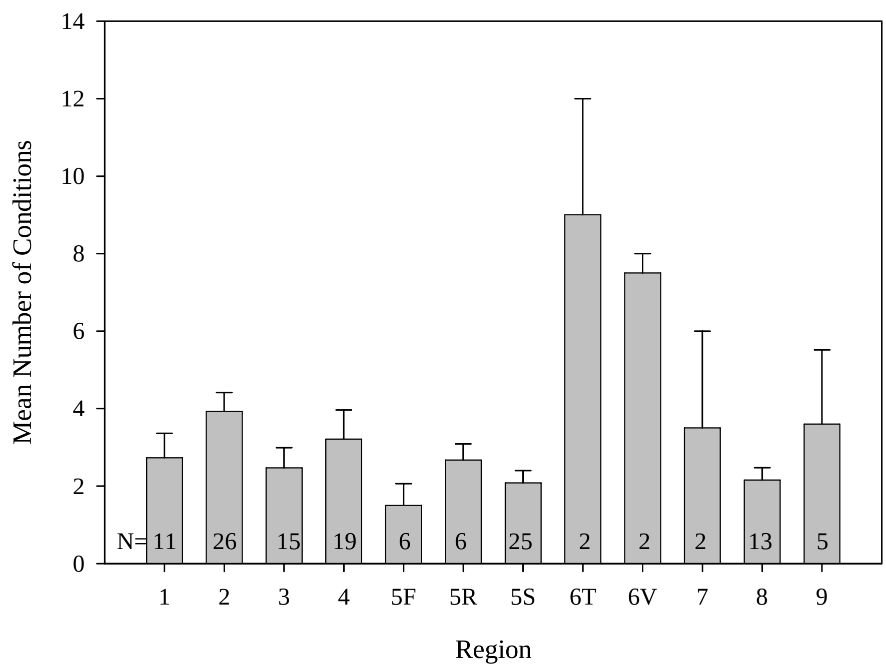

Figure 28. Mean number of mitigation-related 401 conditions per order within each SWRCB Region, including standard error bars (N=132). Eleven files for which no 401 permit was obtained were excluded.

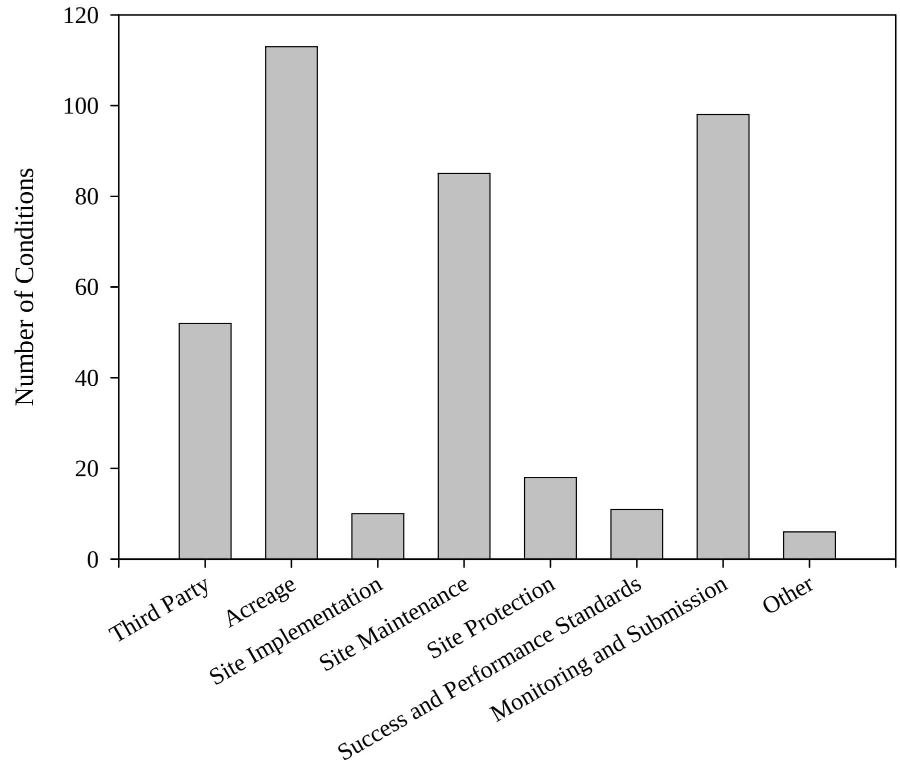

Figure 29. Breakdown of all mitigation-related 401 permit conditions by condition category (N=132).

The conditions from all permit orders were combined into a single list prior to categorization. Eleven files for which no 401 permit was obtained were excluded.

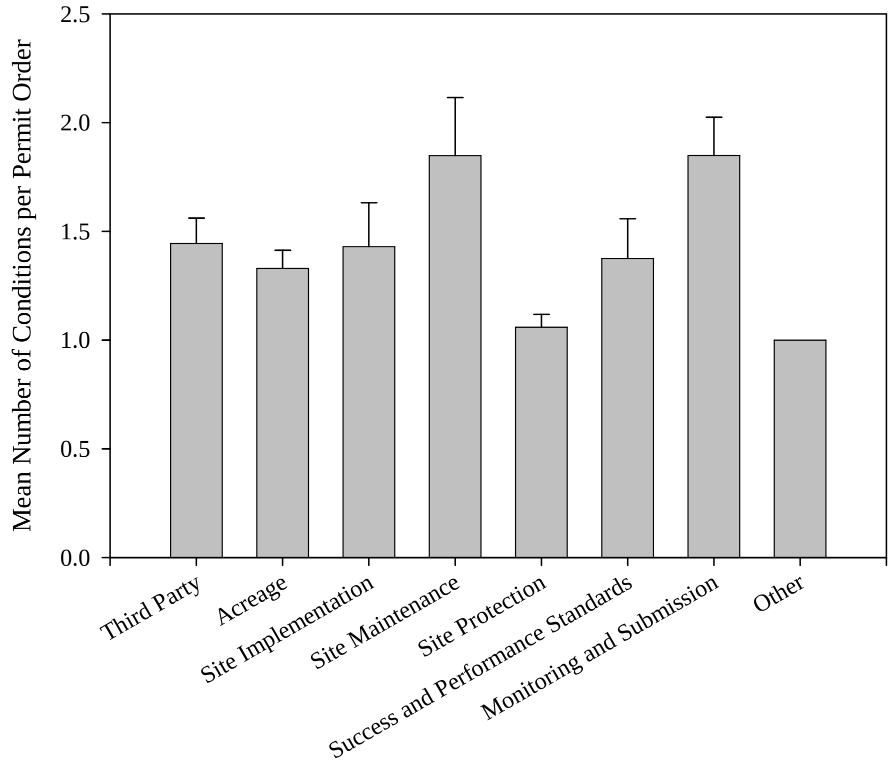

Figure 30. Mean number of mitigation-related 401 permit conditions per permit order (N=132).

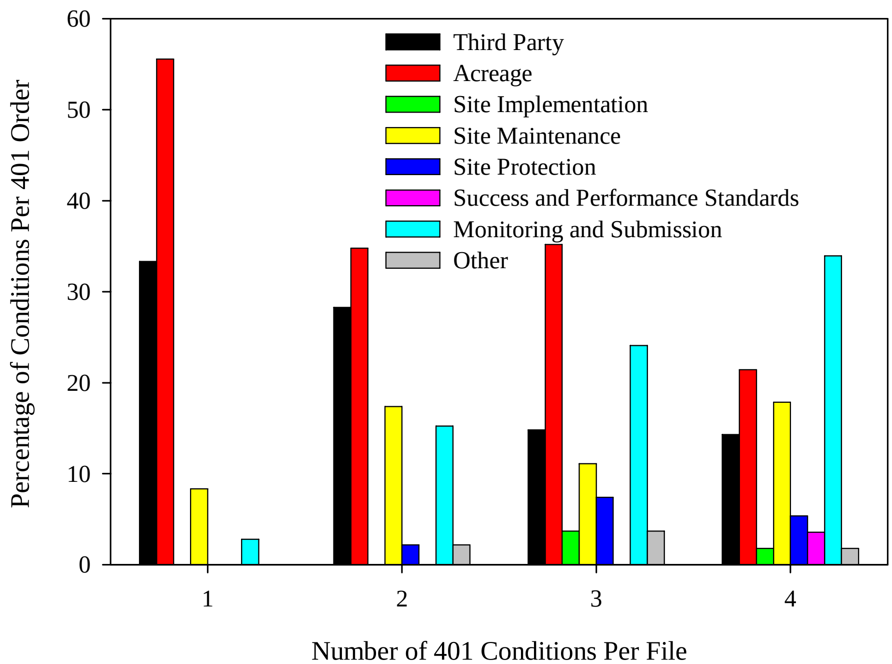

Figure 31. Frequency of occurrence for the eight permit condition categories when the 401 order includes just a single mitigation-related condition, 2 conditions, 3 conditions, or 4 conditions (N=36, 23, 18, 14, respectively).

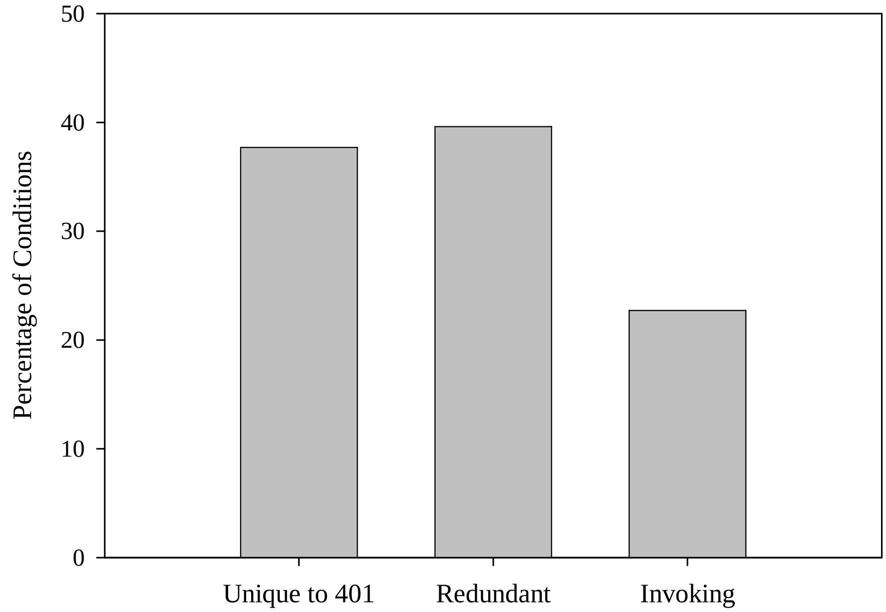

Figure 32. Percentage of mitigation-related conditions found in 401 permit orders that were unique to the 401, redundant with equivalent conditions required by other regulatory agencies, or invoking those other agency permits or the common mitigation plan (i.e., "must follow the 404") (N=115).

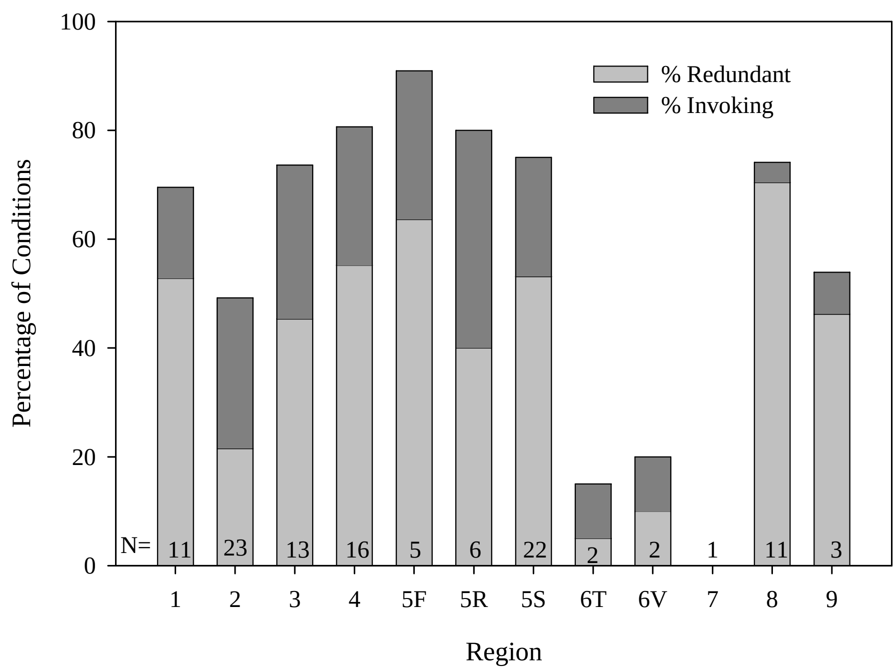

Figure 33. Percentage of redundant and invoking 401 conditions by Region (N=115).

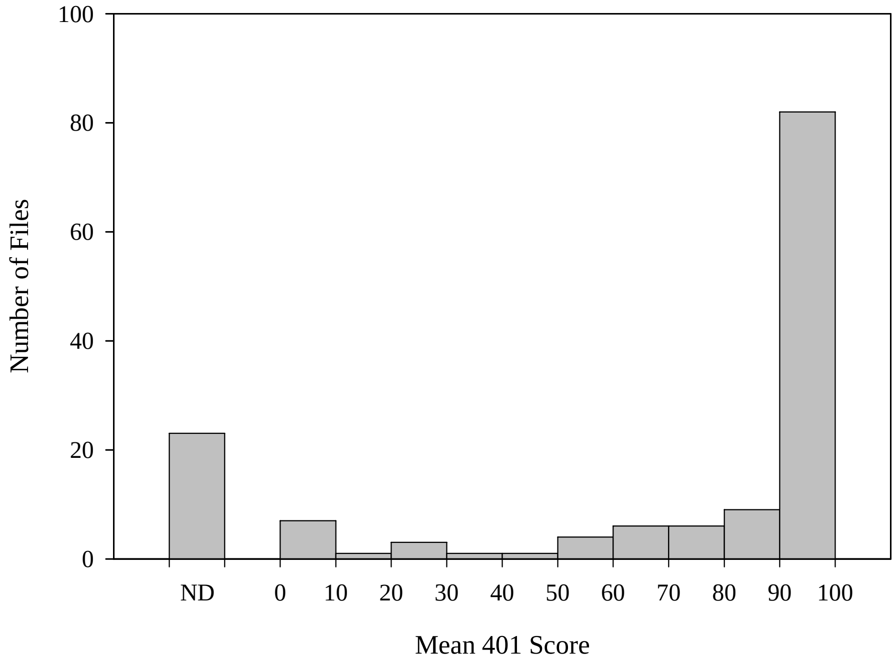

Figure 34. Distribution of files according to the average 401 permit compliance score including only those mitigation conditions explicitly specified in the 401 permit order (N=143).

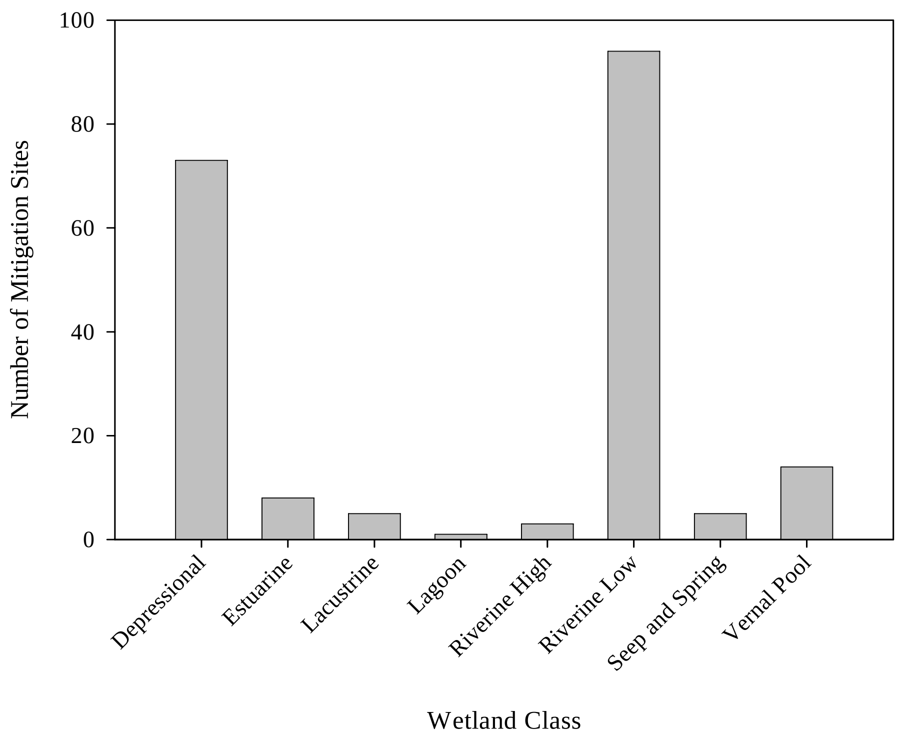

Figure 35. Breakdown of wetland hydrogeomorphic classes as defined and assessed by the CRAM evaluations for all 204 mitigation sites representing 129 files evaluated using CRAM.

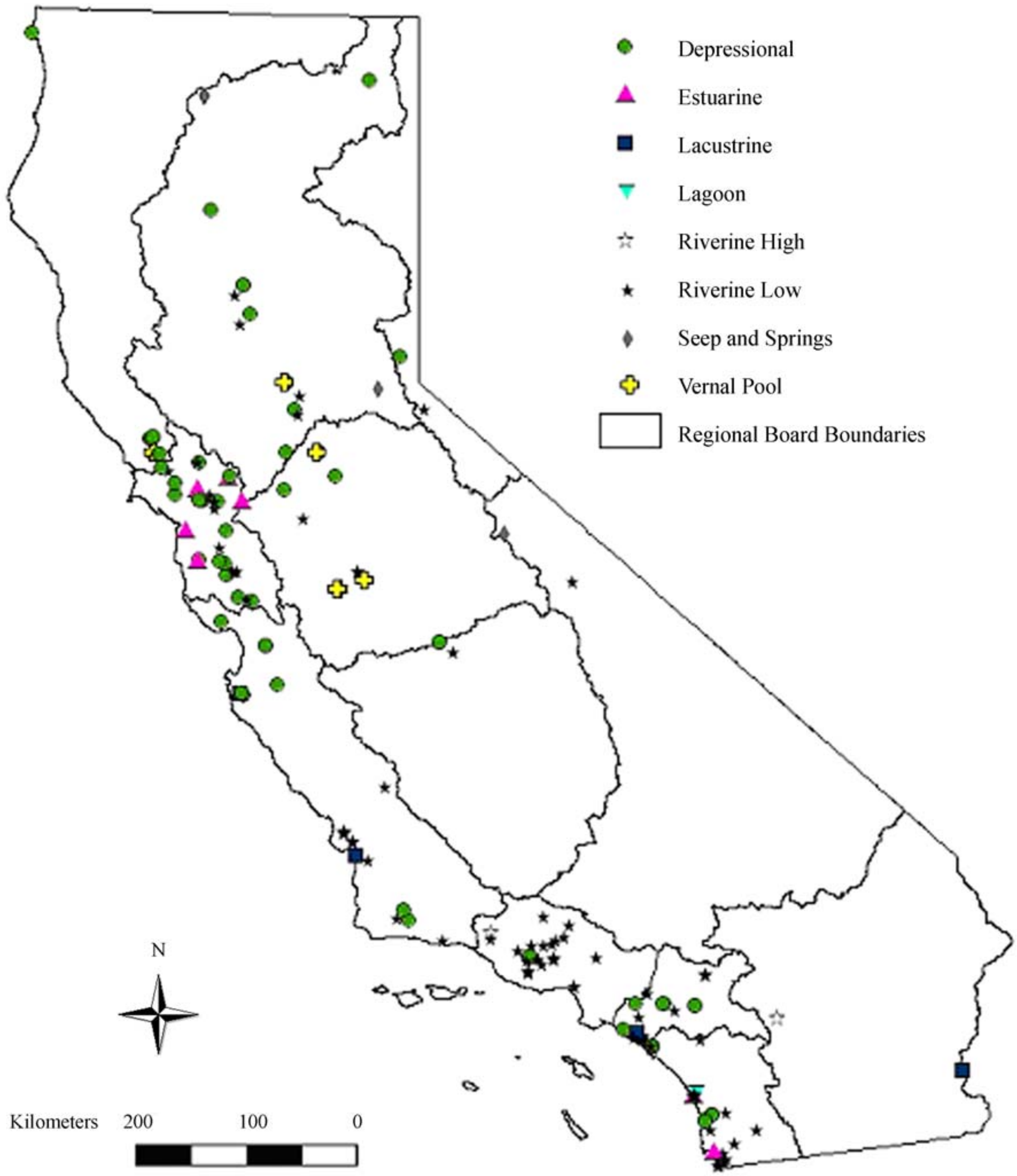

Figure 36. Distribution of assessed mitigation sites by wetland class across the state.

Symbols indicate individual mitigation actions; multiple points may be indicated for individual projects with multiple mitigation actions, and some points may represent multiple projects, e.g., mitigation banks.

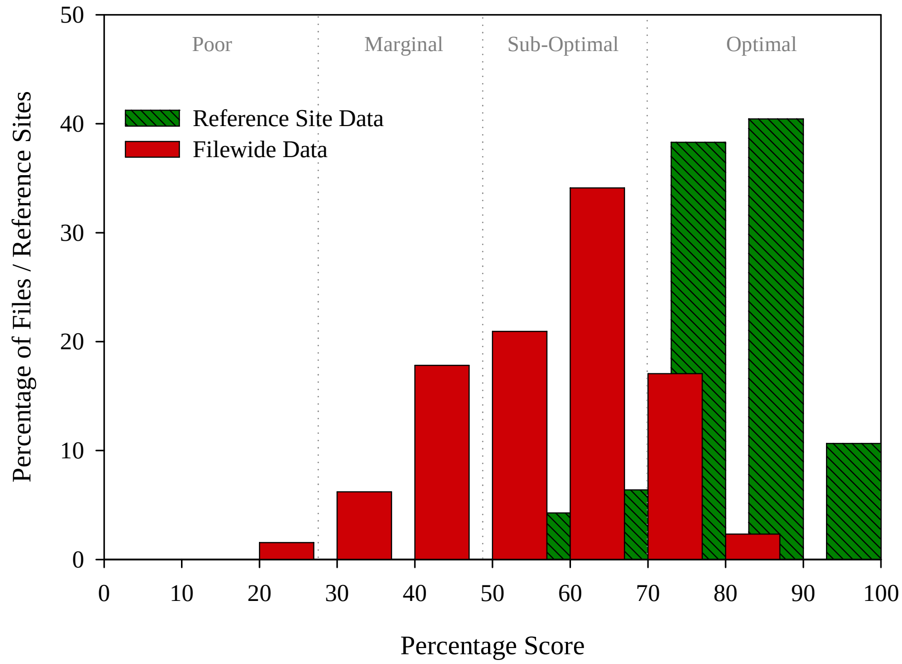

Figure 37. All CRAM data combined into a single overall wetland condition success score for each of the 129 files and 47 reference sites evaluated using CRAM.

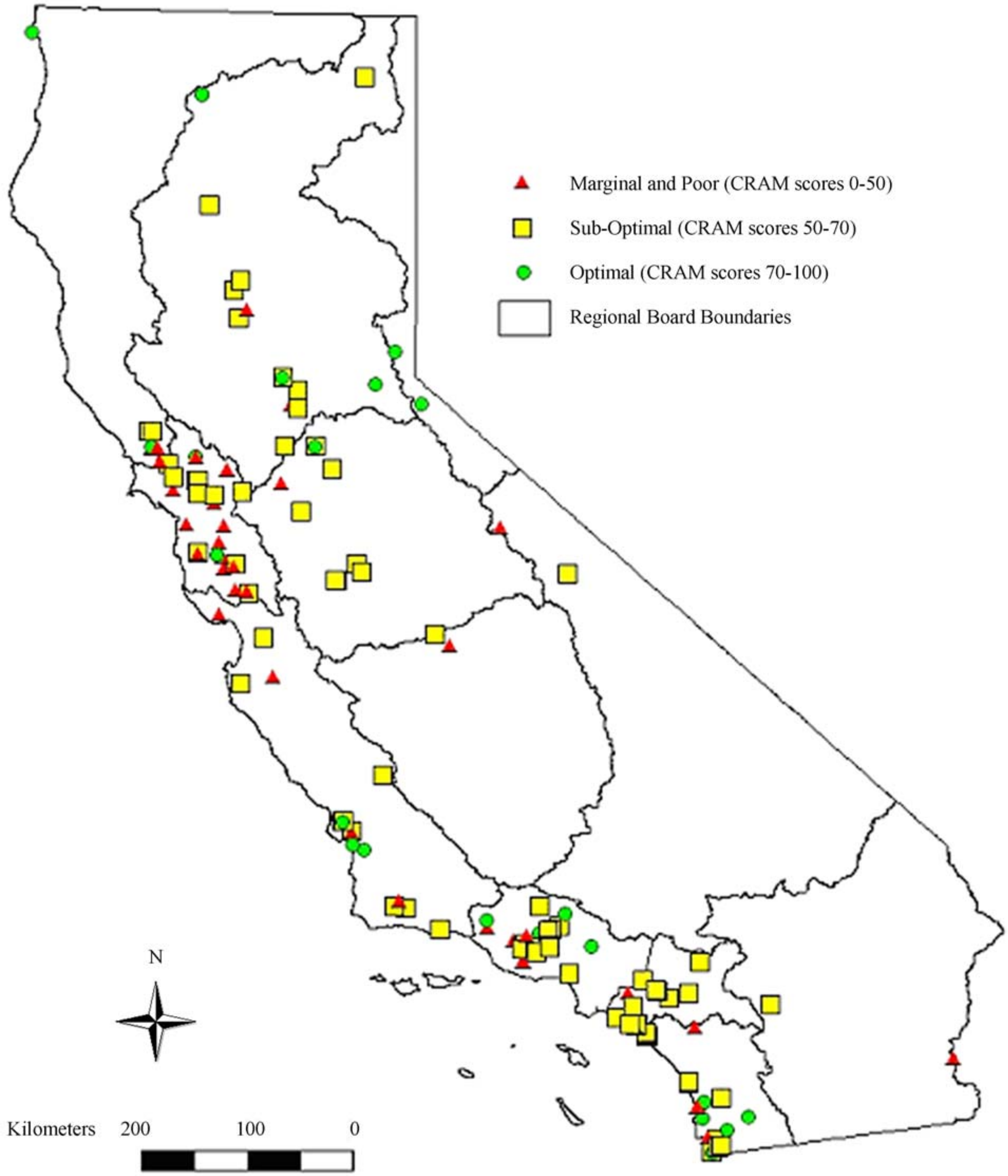

Figure 38. Map of California showing location of mitigation sites color coded by condition score.

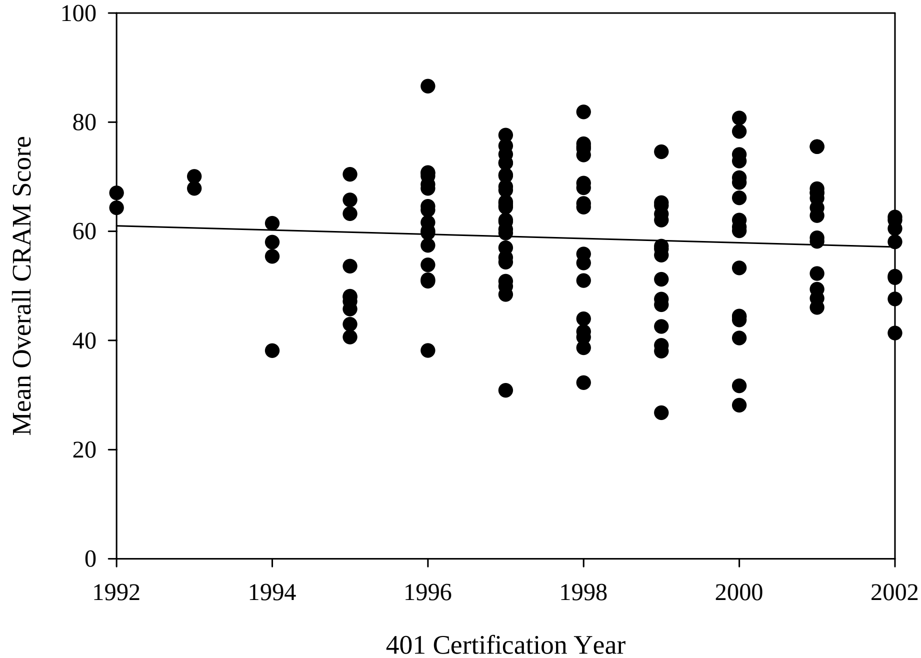

Figure 39. Relationship between 401 certification year and file-wide mean overall CRAM percentage scores grouped by certification year (N=129 files, r^2=0.005, p=0.415).

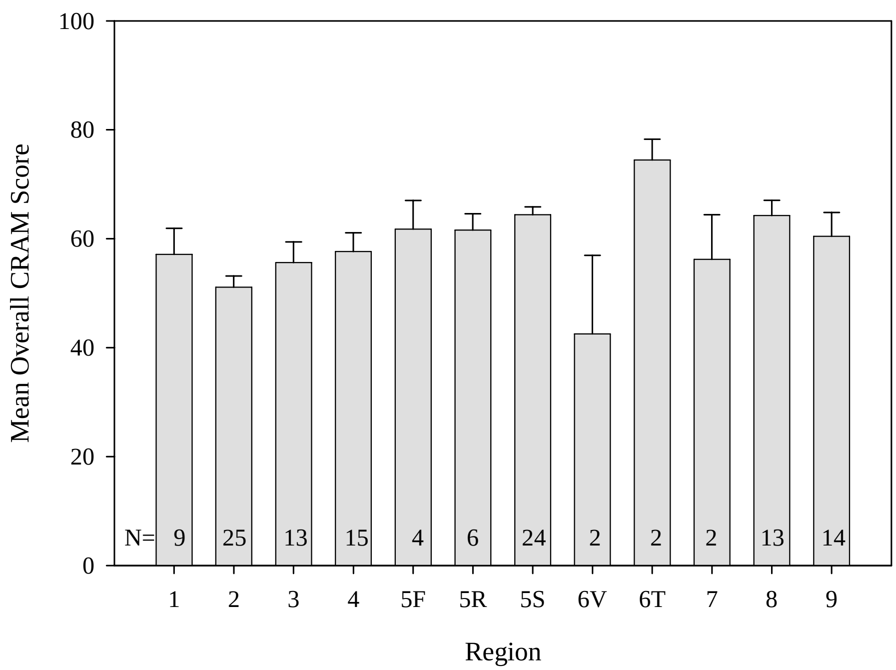

Figure 40. File-wide mean Total-CRAM percentage scores by SB region (N=129 files).

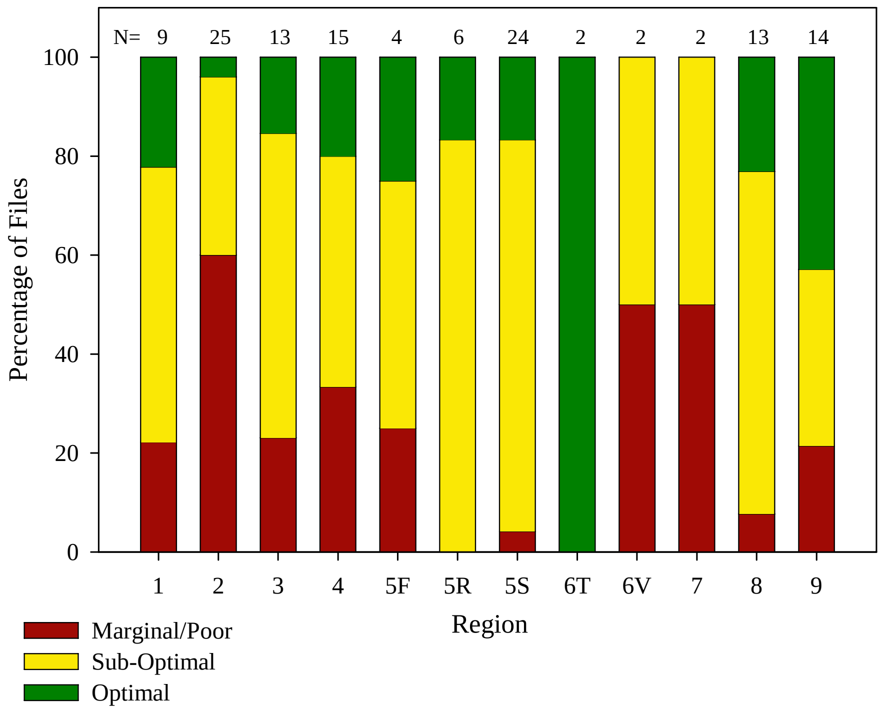

Figure 41. Percentage of files in CRAM success categories by state board region (N=129 files).

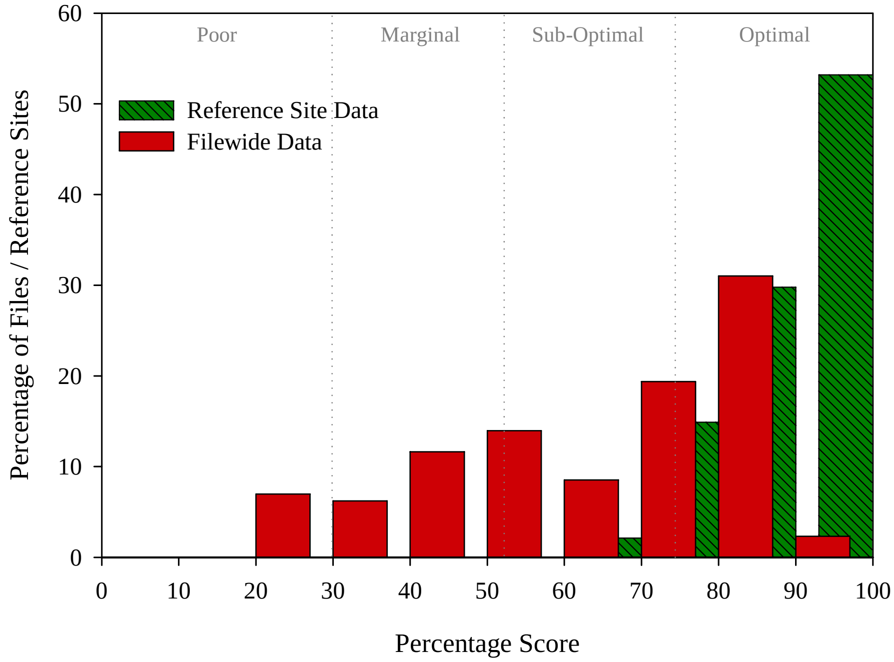

Figure 42. Landscape context attribute CRAM scores compared to reference-site data.

All connectivity, percent of assessment area with buffer, average width of buffer, and buffer condition metrics data combined into a single landscape context score for each of the 129 files and 47 reference sites evaluated using CRAM.

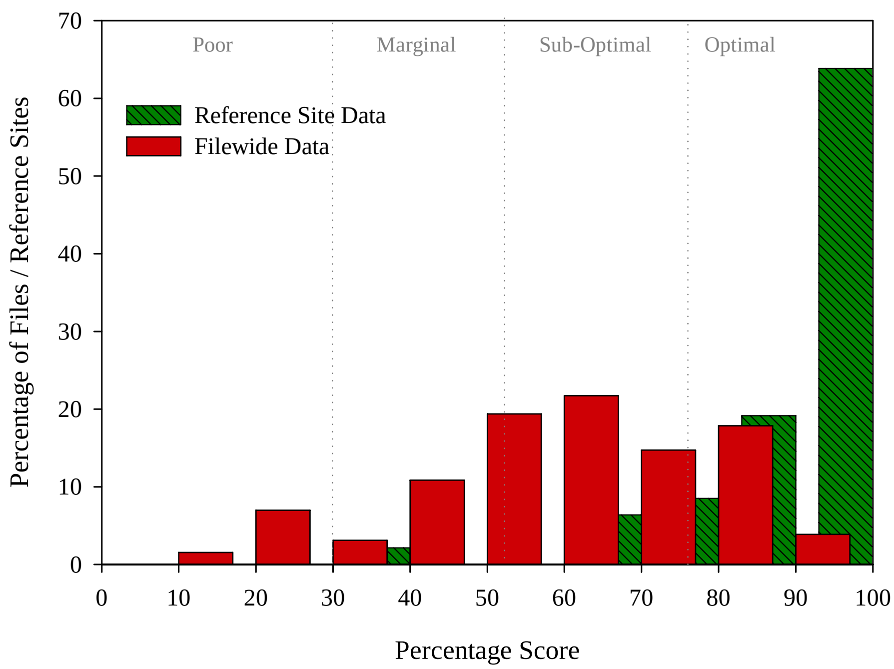

Figure 43. Hydrology attribute CRAM scores compared to reference-site data.

All water source, hydroperiod, and hydrologic connectivity metrics data combined into a single hydrology score for each of the 129 files and 47 reference sites evaluated using CRAM.

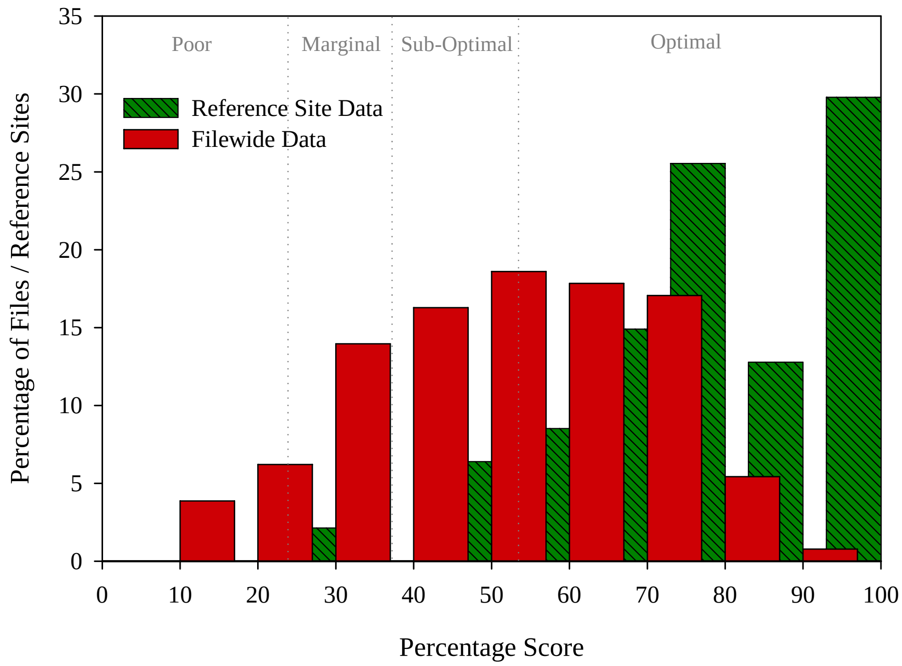

Figure 44. Physical structure attribute CRAM scores compared to reference-site data.

All physical patch richness and topographic complexity metrics data combined into a single physical structure score for each of the 129 files and 47 reference sites evaluated using CRAM.

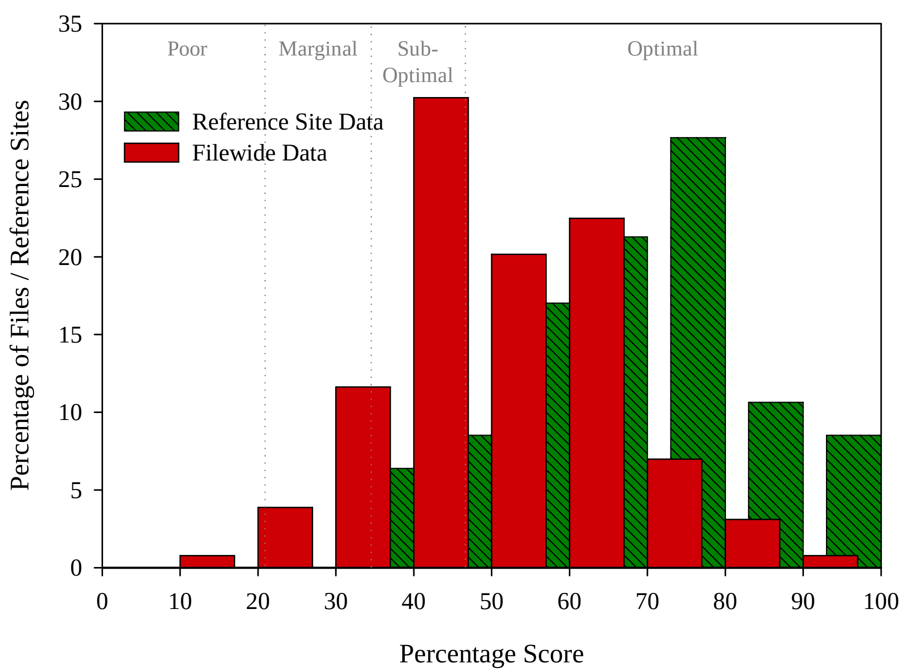

Figure 45. Biotic structure attribute CRAM scores compared to reference-site data.

All organic matter accumulation, biotic patch richness, vertical biotic structure, interspersion and zonation, percent invasive plant species, and native plant species richness metrics data combined into a single biotic structure score for each of the 129 files and 47 reference sites evaluated using CRAM.

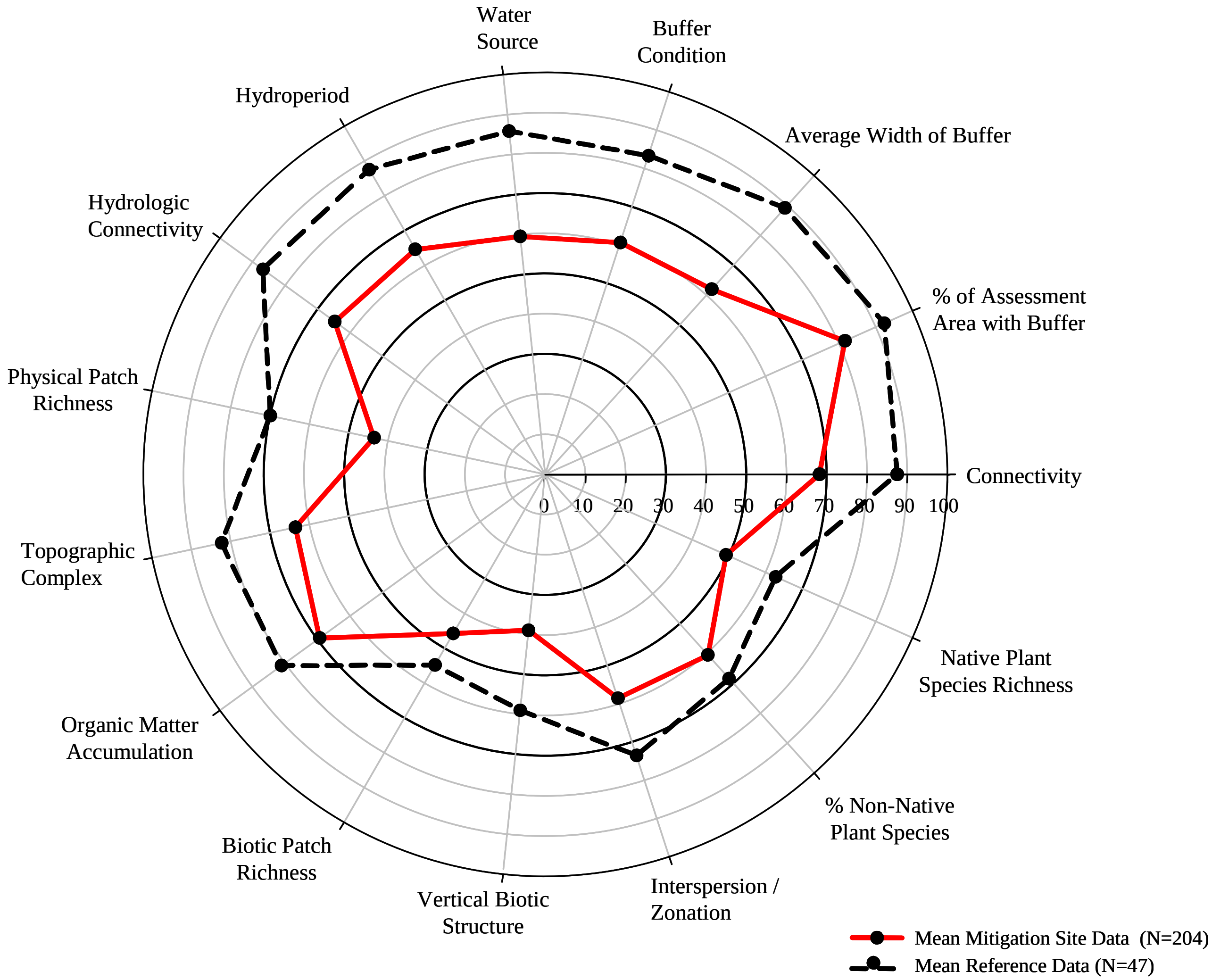

Figure 46. Mean percentage scores for each CRAM metric for mitigation sites (N=204) and reference sites (N=47).

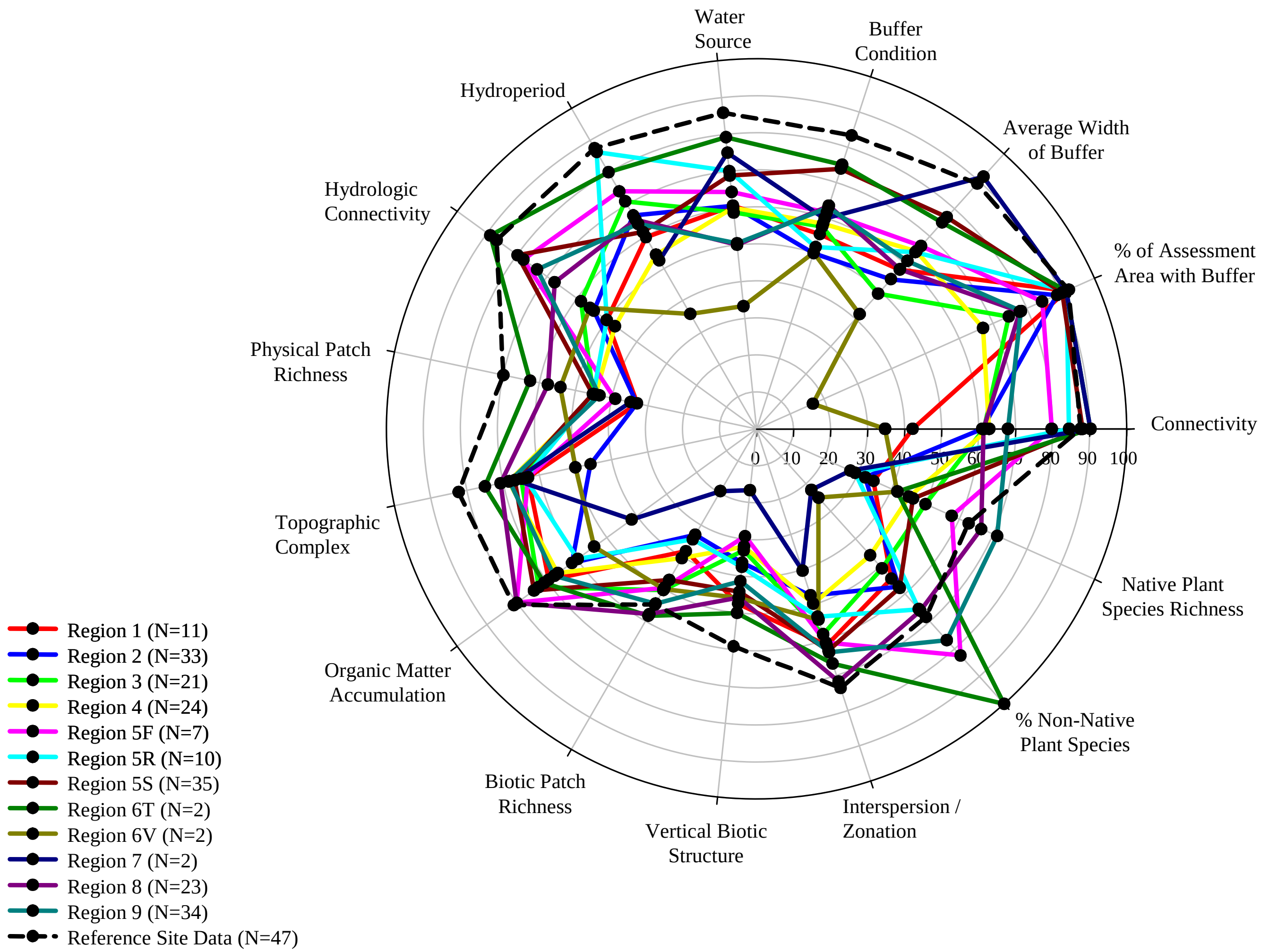

Figure 47. Mean percentage scores for each CRAM metric by state board region. (N=204 mitigation sites)

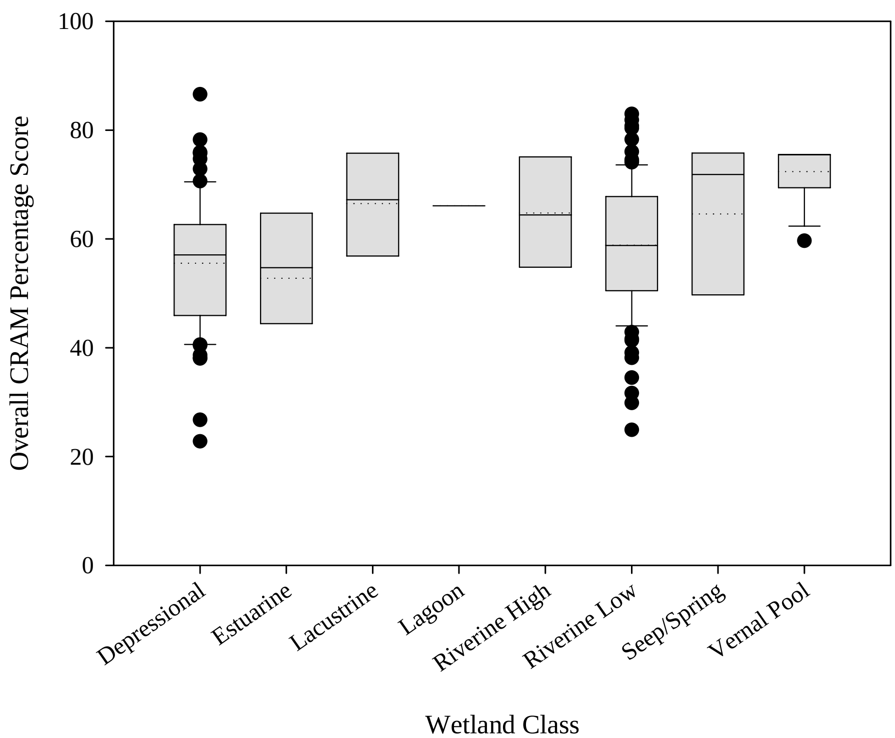

Figure 48. Overall CRAM percentage scores by wetland class (N=204 mitigation sites).

The dotted line represents the mean, the solid line the median. The 10th, 25th, 75th, and 95th percentiles are displayed.

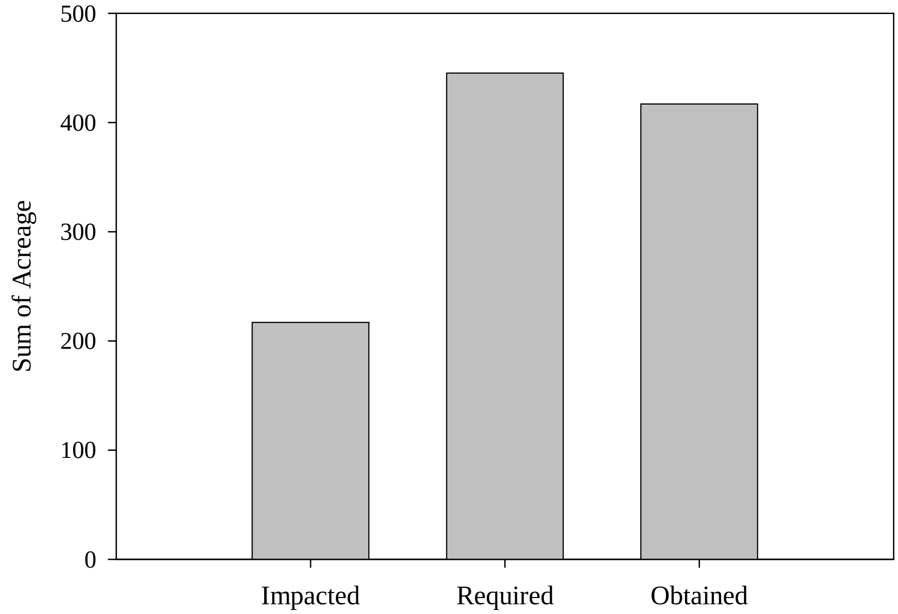

Figure 49. Overall acreage obtained compared to required and impacted (N=143 files).

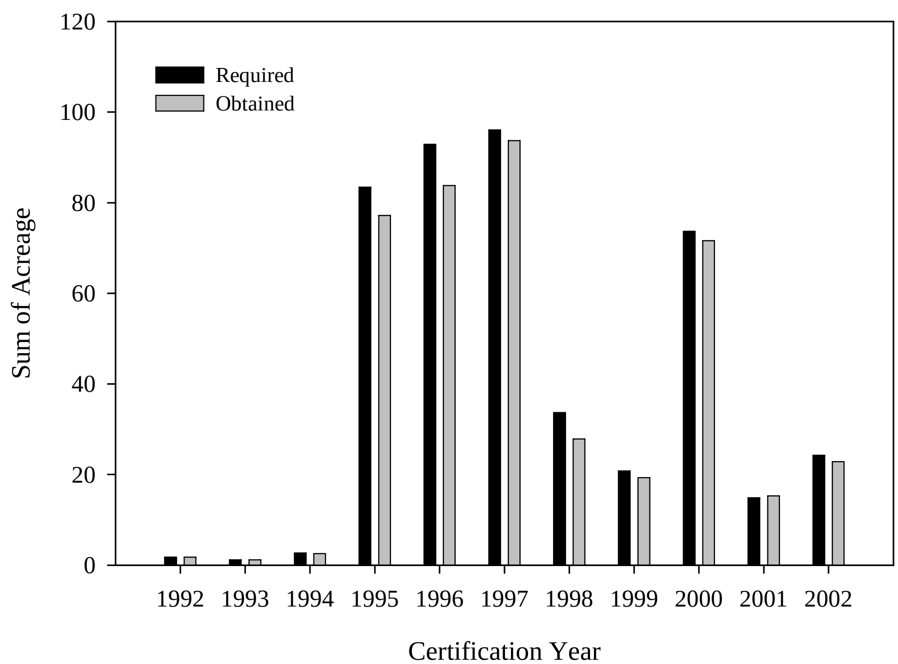

Figure 50. Acreage required and obtained by year (N=143 files).

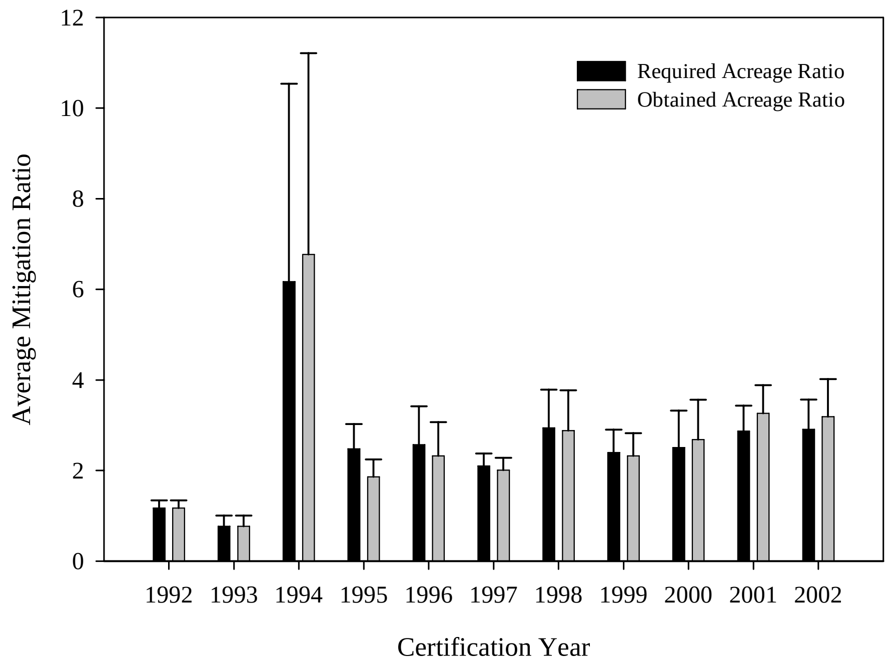

Figure 51. Average mitigation ratios of required and obtained acreage by certification year as determined from our detailed permit file review.

In 2002, one file was removed that had 0.035 acres of impact and 4.30 required and obtained acres, yielding an anomalous mitigation ratio of 122.9. The resulting sample size was N=142.

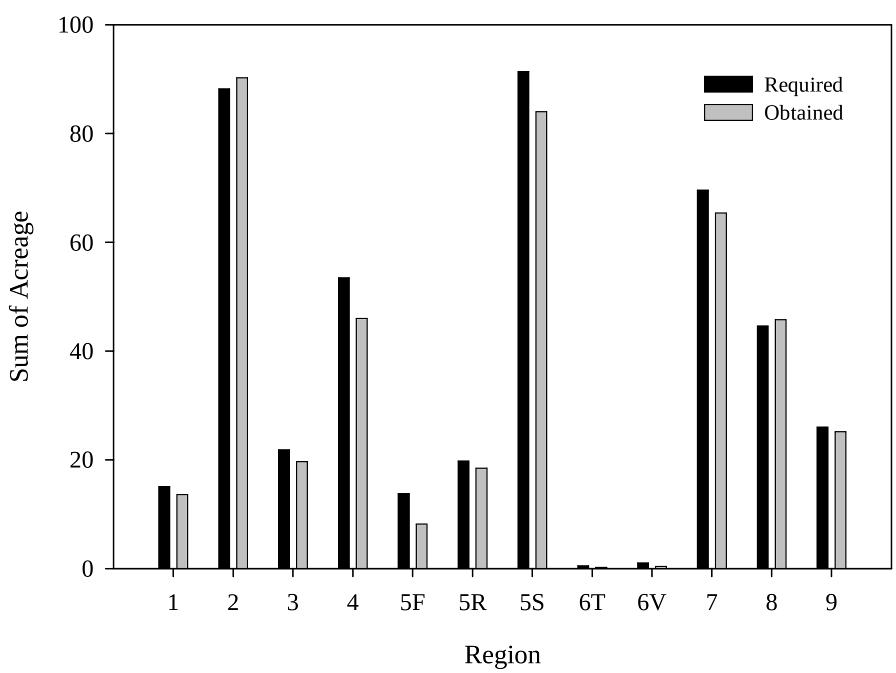

Figure 52. Acreage required and obtained by region.

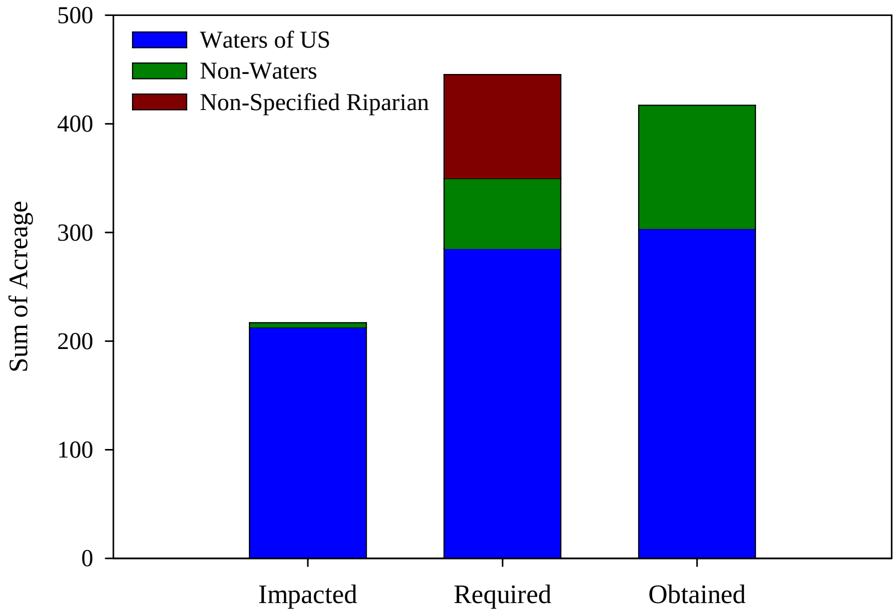

Figure 53. Total acreage impacted, required and obtained for 143 files assessed. Acreage also grouped by jurisdictional habitat classifications: “Waters of the U.S.” and non-jurisdictional waters (Non-“Waters”).

Required acreage also consists of a “Non-Specified Riparian” component, which represents a mitigation requirement of riparian acres, but non-specified jurisdiction (“waters” or non-“waters”).

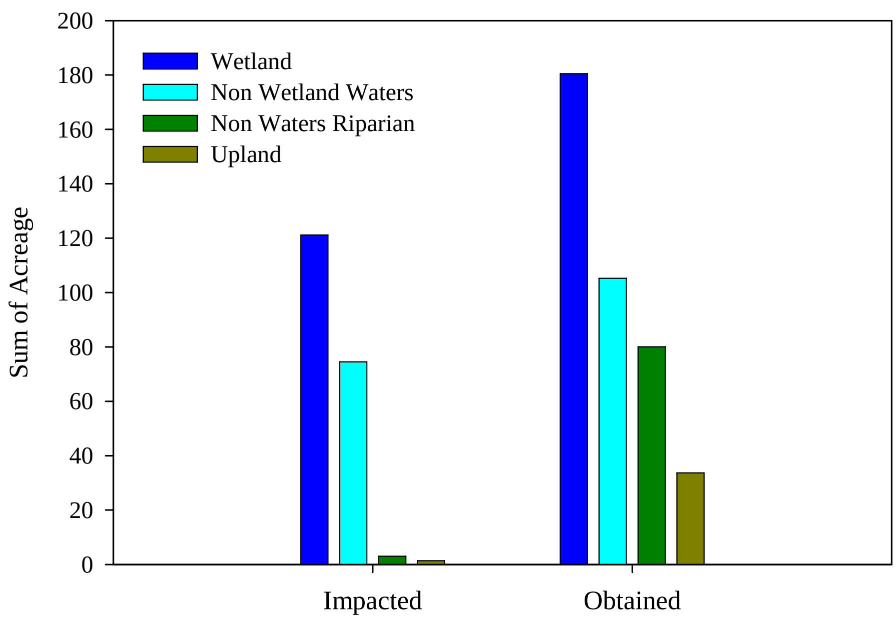

Figure 54. Total acreage impacted and obtained, with jurisdictional habitats data for “waters of the U.S.” proportioned into wetland and non-wetland “waters” habitats, and data for non-“waters” proportioned into riparian and upland habitats.

N=138 files (There are five files for which wetland acreage was not specified for “waters of the U.S.”).

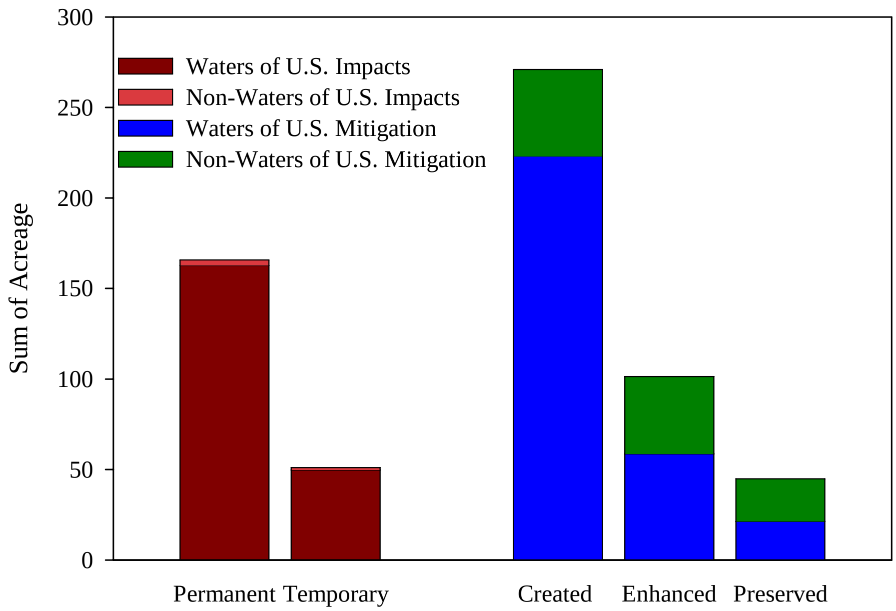

Figure 55. Total acreage impacted proportioned into permanent and temporary impacts, and obtained acreage proportioned into created, enhanced and preserved, each proportioned further into "waters of the U.S." and non-"waters of the U.S." (N=143 files).

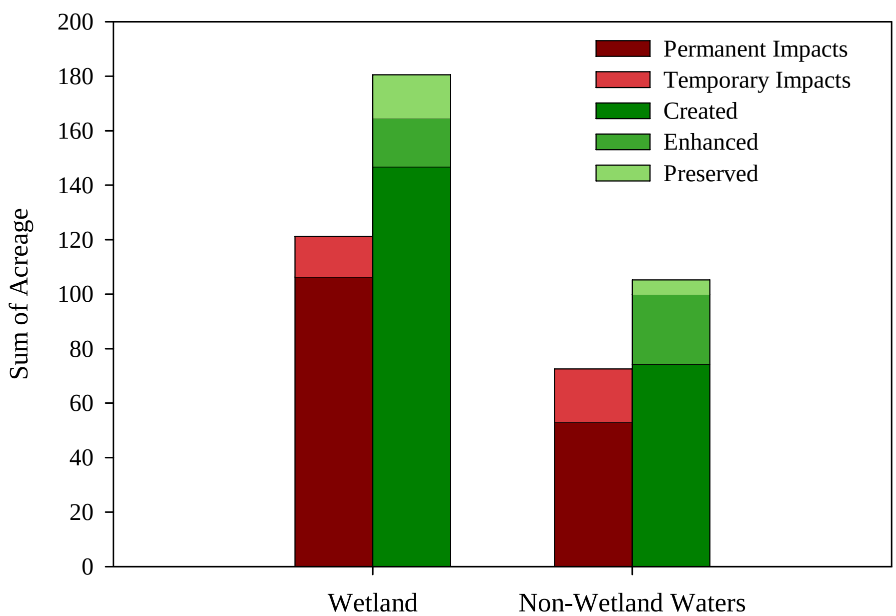

Figure 56. Total acreage for wetland and non-wetland "waters," each displaying impacted and obtained acreage. Impacted acreage is proportioned into permanent and temporary impacts, while obtained acreage is proportioned into created, enhanced and preserved.

N=138 files (There are five files for which wetland acreage was not specified for "waters of the U.S.").

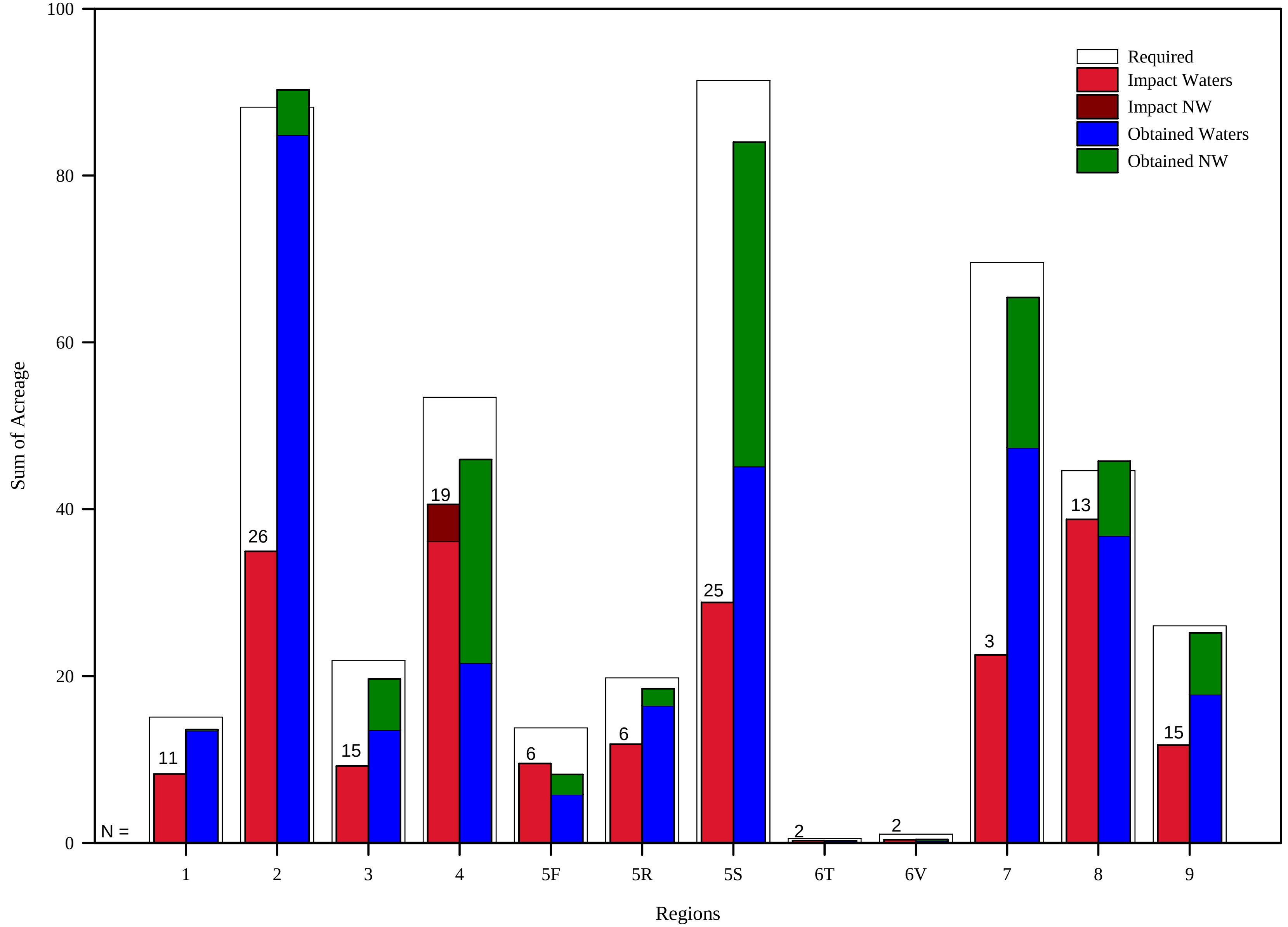

Figure 57. Total acreage impacted and obtained proportioned into "waters of the U.S." and non-"waters of the U.S." by state board region (N=143 files). Total required acreage per region is also displayed. N displayed = number of files assessed per region for both impacted and obtained.

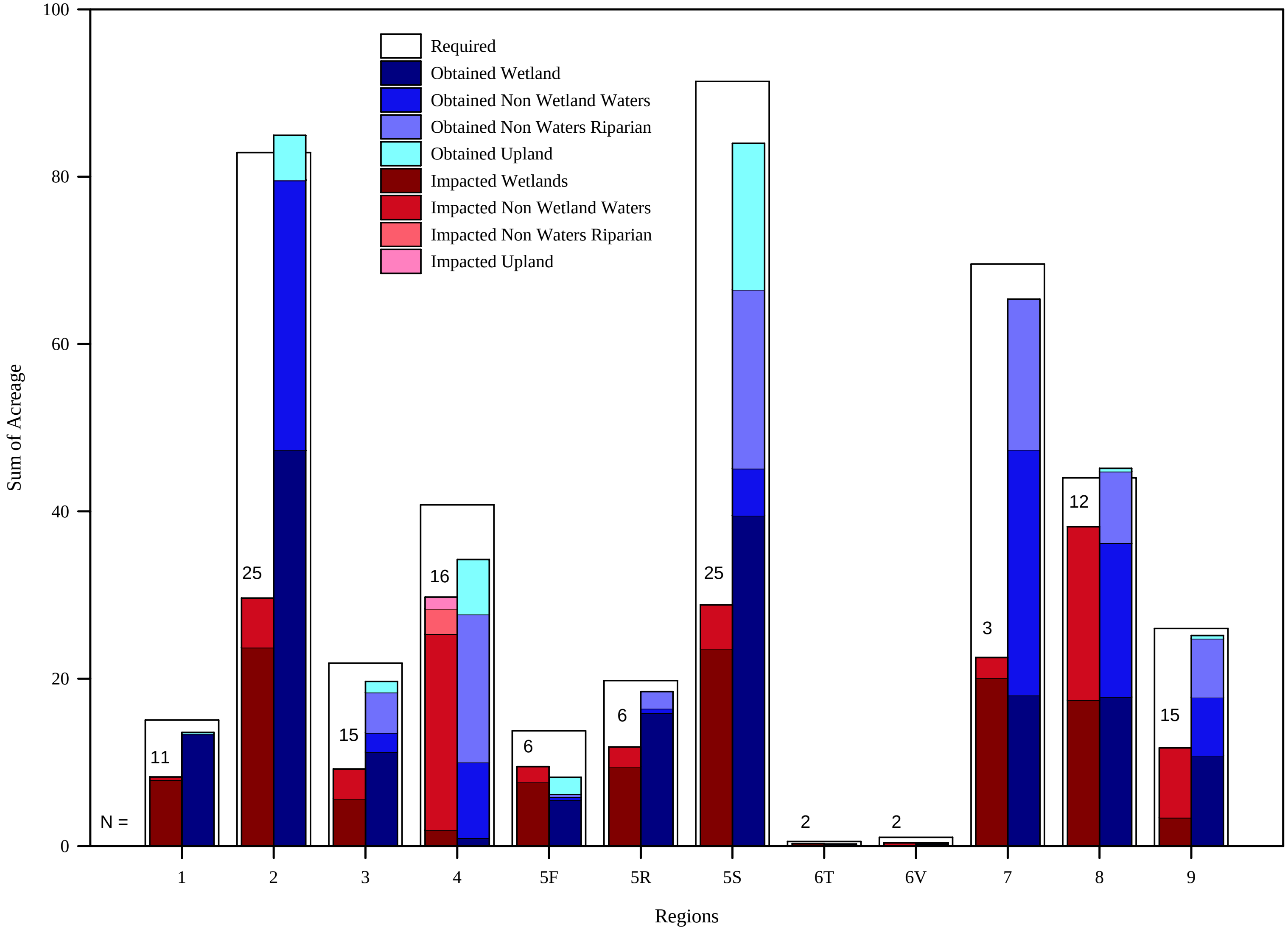

Figure 58. Total acreage impacted and obtained proportioned into wetland, non-wetland "waters," riparian and upland jurisdictional habitats by state board region. Total required acreage per region is also displayed.

N displayed = number of files assessed per region for both impacted and obtained. Total N=138 files (There are five files for which wetland acreage was not specified for "waters of the U.S.").

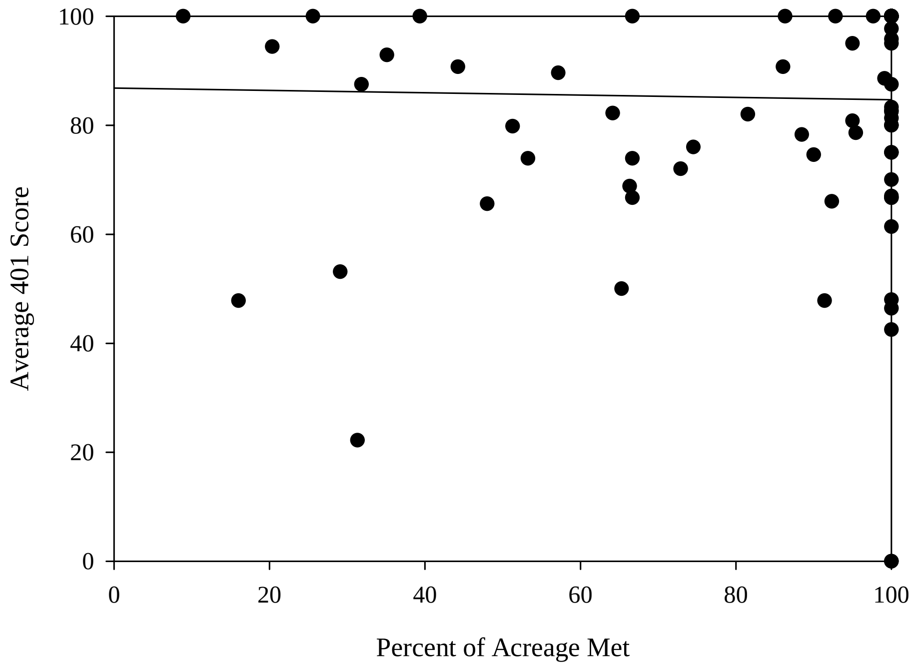

Figure 59. Correlation analysis between percentage of acreage requirement met and average 401 permit compliance score (N=123 files; r^2=0.013, p=0.214).

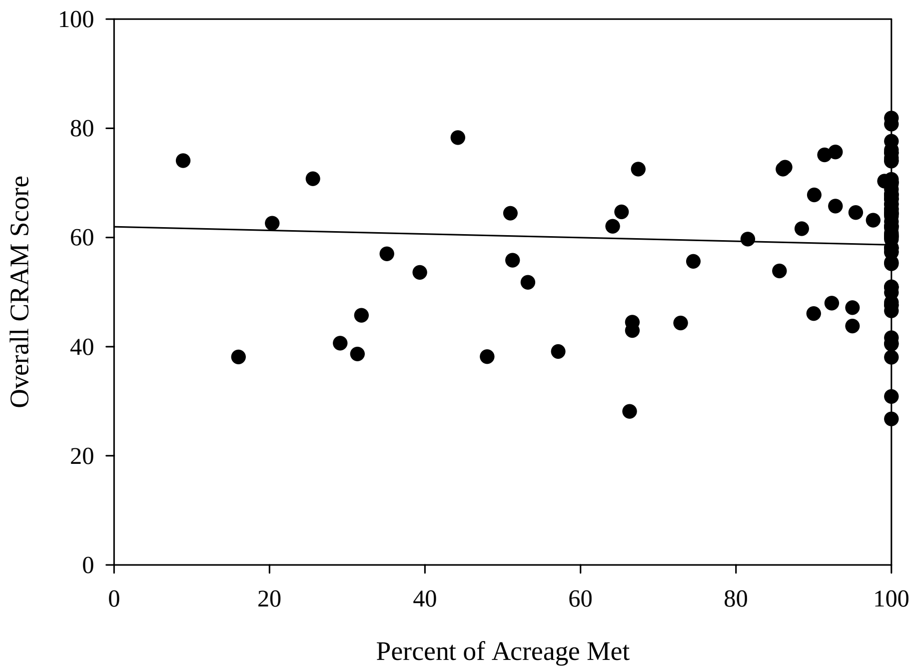

Figure 60. Correlation analysis between percentage of acreage requirement met and overall file-wide CRAM score (N=128 files; r^2=0.015, p=0.173).

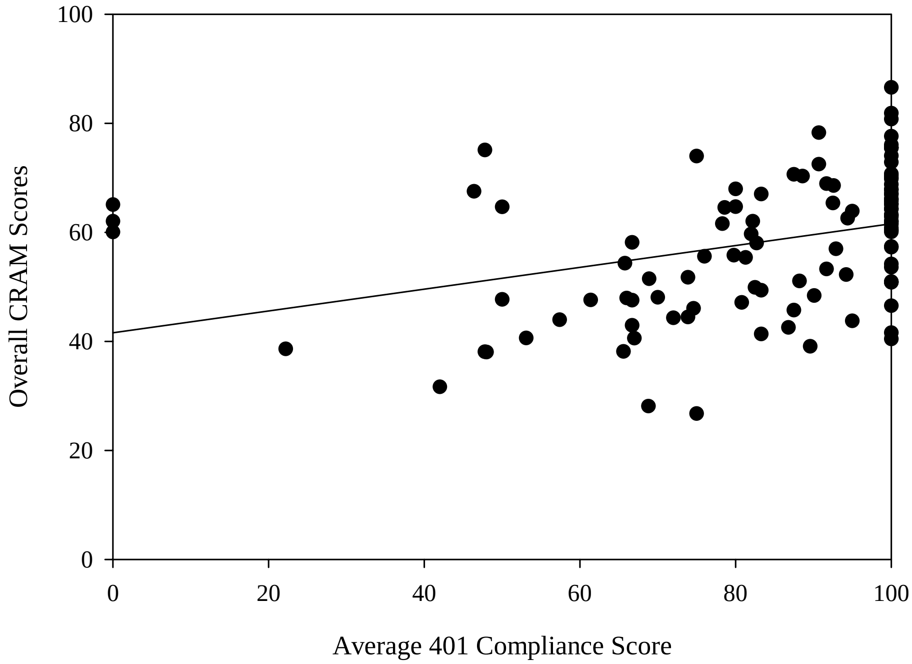

Figure 61. Correlation analysis between average 401 permit compliance score and overall file-wide CRAM score (N= 110 files; r^2=0.126, p=0.000).

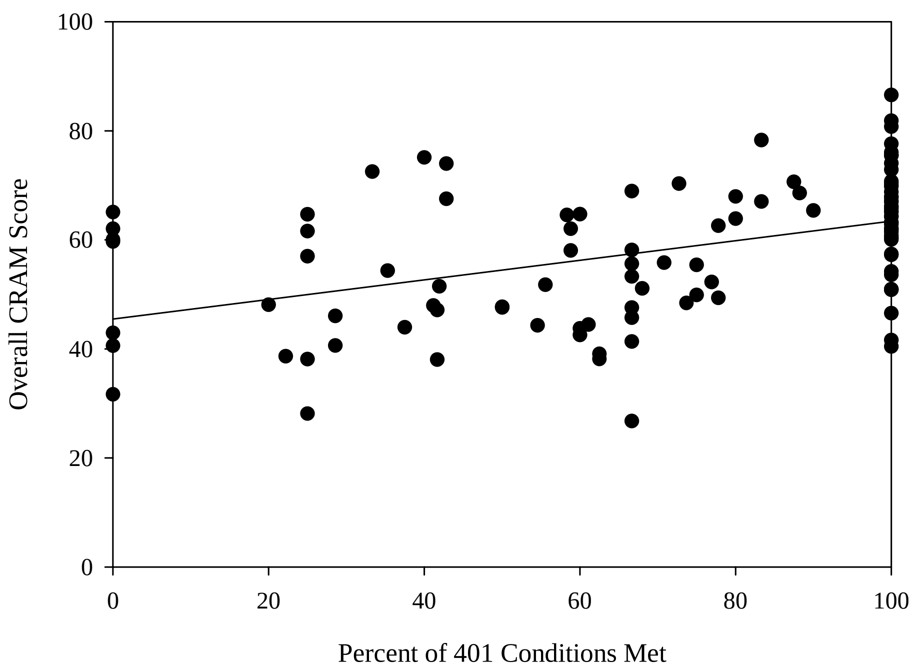

Figure 62. Correlation analysis between percentage of 401 permit conditions met and overall file-wide CRAM score (N=110 files; r^2=0.207, p=0.000).

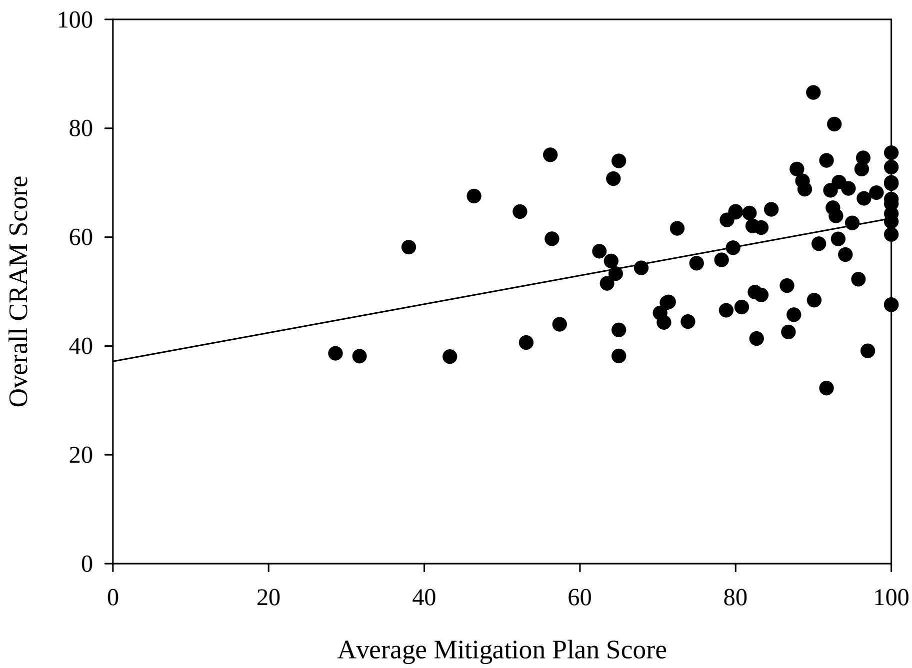

Figure 63. Correlation analysis between average mitigation plan compliance score and overall file-wide CRAM score (N=77 files; r^2=0.150, p=0.001).

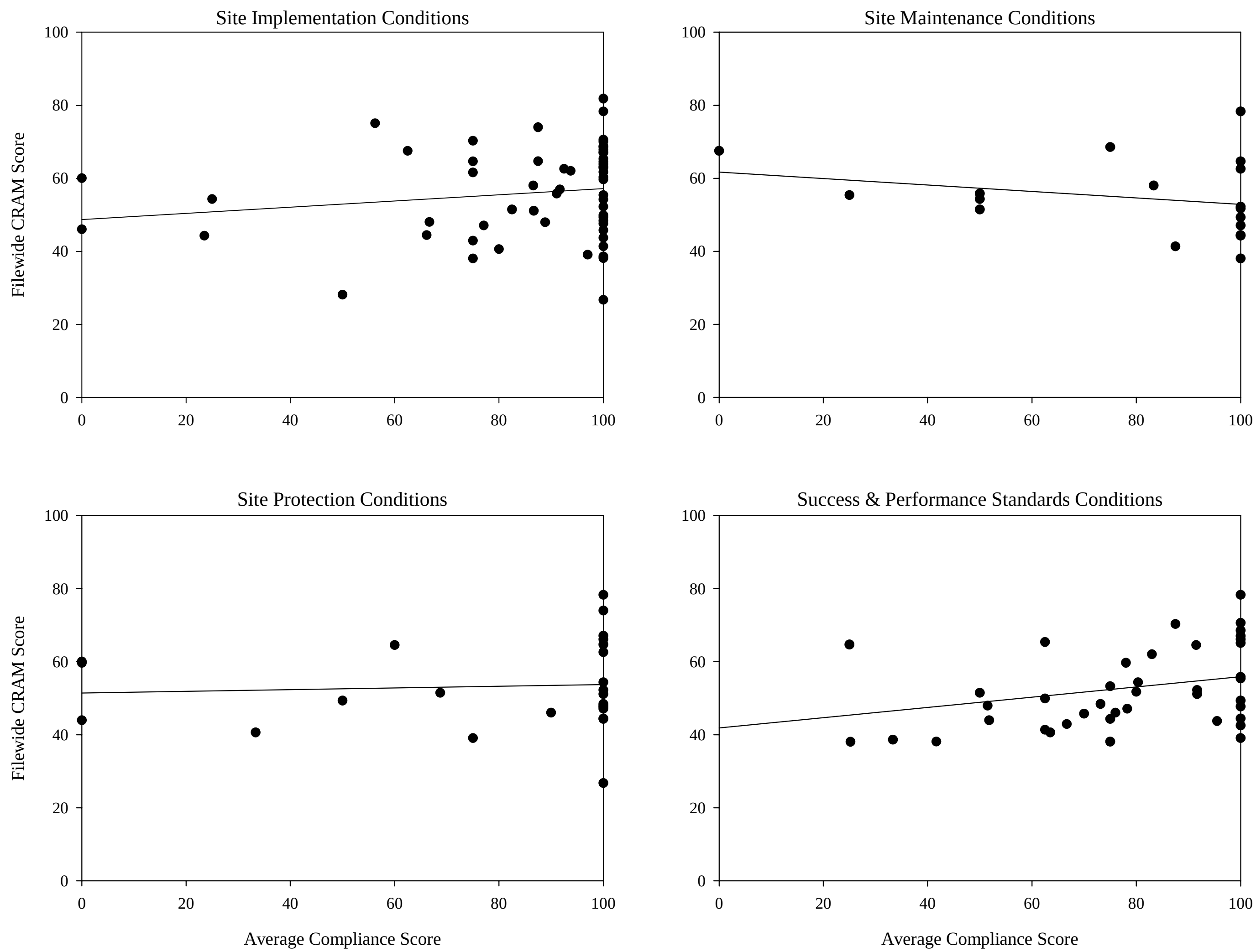

Figure 64. Correlation analysis between overall file-wide CRAM percentage score and average 401 permit compliance score for four of the permit condition categories.

Sample sizes and correlation coefficients per condition category are as follows: for site implementation N=57, r^2=0.027, p=0.219; site maintenance N=18, r^2=0.068, p=0.297; site protection N=25, r^2=0.005, p=0.743; success/performance standards N=42, r^2=0.091, p=0.052. See Methods for description of permit condition categories.

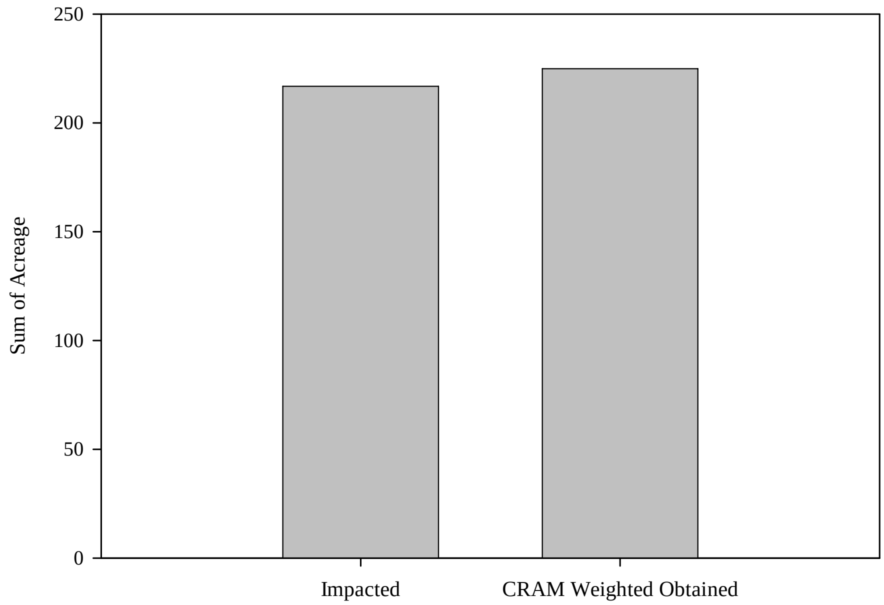

Figure 65. Total impacted acreage and obtained acreage weighted by condition score (N=129 files).

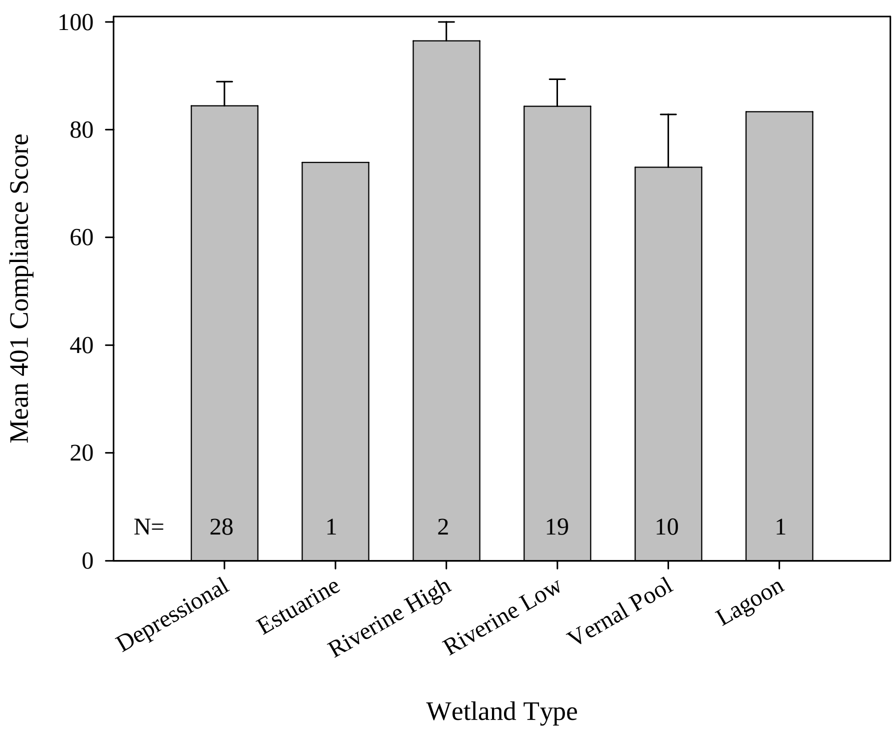

Figure 66. Mean 401 compliance score for different wetland types.

Includes invoked conditions; N=61 files