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Wetland ecological and compliance assessments in the San Francisco Bay Region, California, USA[☆]

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Abstract

The San Francisco Bay Region of the California Regional Water Quality Control Board (SFB CRWQCB) and the San Francisco District of the US Army Corps of Engineers (US ACOE) are looking for an expeditious means to determine whether regulated wetland projects produce ecologically valuable systems and remain in compliance with their permits (i.e. fulfill their legal requirements) until project completion. A study was therefore undertaken in which 20 compensatory wetland mitigation projects in the San Francisco Bay Region were reviewed and assessed for both permit compliance and habitat function, and this was done using a rapid assessment method adapted for this purpose. Thus, in addition to determining compliance and function, a further goal of this study was to test the efficacy of the assessment method, which, if useful, could be applied not only to mitigation projects, but also to restoration projects and natural wetland systems.

Survey results suggest that most projects permitted 5 or more years ago are in compliance with their permit conditions and are realizing their intended habitat functions. The larger restoration sites or those situated between existing wetland sites tend to be more successful and offer more benefits to wildlife than the smaller isolated ones. These results are consistent with regulatory experience suggesting that economies of scale could be realized both with (1) large scale regional wetland restoration sites, through which efforts are combined to control invasive species and share costs, and (2) coordinated efforts by regulatory agencies to track project information and to monitor the increasing number and size of mitigation and restoration sites. In regard to the assessment methods, we find that their value lies in providing a consistent protocol for evaluations, but that the ultimate assessment will rely heavily on professional judgment, regulatory experience, and the garnering of pre-assessment information.

Keywords: Wetlands; Wetland assessments; Compensatory mitigation projects; Clean Water Act; San Francisco; California

1. Introduction

Under the national and California ‘no net loss of wetlands’ policy, attempts are made to avoid wetland losses whenever possible. In the regulatory context, when the permit applicant has attempted, but has been unable, to avoid or minimize such losses, compensatory mitigation projects are required to offset the adverse impacts on existing wetlands. The policy also supports projects for restoration, creation, and preservation or enhancement of wetlands.[1] In order to measure

[☆] The opinions presented here are those of the author(s) and do not necessarily represent the opinions of the affiliated agencies represented.

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[1] The following terms apply to wetland projects: restoration is used here to describe the return of functions that once existed in the area but that do not presently exist. Creation refers to establishing wetland functions to a site where they never existed. Enhancement refers to improving functions at an existing wetland site. Preservation refers to maintaining a wetland in its existing condition and providing some mechanism to maintain its current state.

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the need for and success of such projects, an efficient and accurate wetland assessment method has long been sought.

Over 40 wetland assessment methods have been published since 1990 and more are being developed (National Research Council, 2001; Bartoldus, 1999, 2000). Other methods are not formally categorized or extensively tested, but perform the same general function of evaluating sites for biological, hydrological, or physio-chemical success or for compliance with regulatory permits (e.g. DeWeese, 1994; Stein and Ambrose, 1998). There have been repeated calls over the last two decades for 'science-based' assessment methods, but few have proven to be reliable in all regions or even in the same region over a substantial amount of time. At the same time, databases run by regulatory agencies are becoming bloated with useless project information that cannot always answer questions as basic as 'where is the project site?', 'what are the goals?', and 'what are the criteria used to determine project success?' Too much is left to institutional memory, which relies on people who are likely to be unavailable when the projects or their monitoring periods are completed.

We reviewed many assessment methods and selected one that gave more attention than most to the presence of wildlife in wetlands. In the San Francisco Bay Region, wildlife habitat is one of the primary functions served by a stream or wetland to be filled, but most evaluation methods do not specifically evaluate this aspect of wetland projects. The method chosen was the Wetland Rapid Assessment Procedure (WRAP), a rating index developed by the South Florida Water Management District (Miller and Gunsalus, 1999). We then modified and adapted the WRAP to better reflect the conditions of San Francisco Bay Area habitats. We call the revised method, the Wetland Ecological Assessment (WEA).

Major changes made to the WRAP to develop the more regionally sensitive WEA included:

- *Wildlife Habitat*. The addition of 'native' to the major categories and the ability to give extra points to a site for the known presence or potential to have special status species.
- *Vegetation*. The combination of 'overstory and shrub canopy' and 'vegetative groundcover' into one form with three layers, namely, herbaceous, shrub, and tree. There is still the ability to score by half increments and to weigh components of each layer separately for the percent of target native vegetation, vigor and reproduction, structural diversity, and invasive exotics. There is also the option to score each site based on a composition, structure, or re-establishment ranking that relies heavily on the site's similarity to native vegetation.
- *Adjacent buffer*. The adjustment of category headings with varying amounts of desirable vegetation increasing the score.
- *Hydrology*. The removal of some specific indicators which do not generally apply to California wetlands, e.g. vegetated tussocks; a lack of soil subsidence as a wetland indicator in sites with organic soil substrate.
- *Surrounding land use*. The removal of references to citrus groves and sugar cane, and the combination of all farming under agriculture (which includes vineyards) and dairies.
- *Water quality*. This metric was not included in the WEAs conducted for this report, but we have recommended that it be tested in future assessments.

The purpose of both the WRAP and the WEA is to assist in the regulatory evaluation of permitted mitigation or restoration sites (i.e. wetland sites that are created, restored, enhanced or preserved). The stated objectives of South Florida's assessment method are to:

1. establish an accurate, consistent, and timely wetland assessment tool;
2. track trends over time (land use vs wetland impacts); and
3. offer guidance for environmental site plan development.

Both the WRAP and the WEA evaluations are rapid assessments, to be used within the limited timeframes of the regulatory process. Test results of the WRAP procedure used in Florida showed it to be highly repeatable and an effective training tool for biologists (Miller and Gunsalus, 1999). A recent US EPA report on wetlands assessment methods found the WRAP to be one of seven out of over 40 methods reviewed that had the following desirable characteristics: the ability to (1) measure condition; (2) be rapid; (3) be conducted on site; and (4) be verified (Fennessy et al., 2004).

It is important to note that our purpose in testing and developing wetland assessments in the San Francisco Bay Region was twofold: (1) to determine whether mitigation sites were producing viable wetlands and (2) to assess the extent of permit compliance. Given the large number of assessment methods available, and given our small sample size of 20 projects, results are intended only to provide preliminary guidance for further research and development of wetland assessment methods used in California and the United States.[2]

[2] The results of the WEA scores are particularly well suited to comparisons with two other rapid assessment methods: (1) the Rapid Impact Assessment Method (RIAM) developed for use in Southern California for riparian habitat assessments and (2) a method currently being developed by the US EPA (Region 9), the San Francisco Estuary Institute, Southern California Wetland Recovery Project, and several other entities in California with the broad participation of agencies likely to implement a state-wide wetland assessment method (e.g. the California State Water Resources Control Board, the San Francisco Bay and Los Angeles Regional Water Quality Control Boards, and the US Army Corps of Engineers, among others). This method has been denominated as the California Rapid Assessment Method (CRAM). The CRAM seeks to develop reliable scientific methods for rapid assessments for use in California, and to follow up rapid assessments with intensive field monitoring that could take several years per site to complete (Collins et al., 2004). CRAM is derived from the Ohio Rapid Assessment Method (ORAM), which in turn relies heavily on the Washington State Wetlands Rating System. The major metrics used in most of these assessment methods, including the WEA, are typically vegetation, hydrology, surrounding land use, and buffer quantity and quality.

2. Methods

2.1. Office methods

A database was developed in 1994–1995 at the San Francisco Bay California Regional Water Quality Control Board (SFB CRWQCB), with the assistance of the US Army Corps of Engineers (US ACOE). This database was designed to track all the components of compensatory wetland mitigation projects necessary to monitor their success upon project completion, usually 5–20 years after hydrology is established (Holland and Kentula, 1991). Information was collected on approximately 120 projects that were permitted between 1988 and 1995. The information included project goals, wetland habitats affected, performance criteria, monitoring elements, and reference sites used.

In 2003, we randomly selected 18 of these projects from the database to determine whether they were in compliance with their permits and whether they had produced acceptable wetlands to compensate for destroyed wetlands. Two additional projects were deliberately selected because of their large size and high profile (Sonoma Baylands and Roberts Landing). Three of the original 18 randomly selected projects could not be evaluated because they were known to be out of the region, to have never happened, or to have been inaccessible.[3] Consequently, three non-random projects with completed monitoring periods were selected as replacements (Red Top Road, Coyote Creek, and Fleeman Property). Two others were visited in the field but not completely evaluated because they either had been avoided completely but not removed from the database (Mayhews Landing), or were part of a larger project that could not be differentiated at the time of the assessment (Bettencourt Detention Basin). All of the final 20 wetland sites selected for evaluation were located throughout the San Francisco Bay Region (Fig. 1).[4] Table 1 lists the 20 wetland projects visited and/or evaluated in the spring of 2003.

Background information not contained in the database was researched at the SFB CRWQCB office in Oakland, CA or the US ACOE office in San Francisco, CA. The required office data, which deals with project compliance and is typically found in permits and monitoring reports, is listed in Appendix A. This appendix is based primarily on the experience of staff at the SFB CRWQCB and US ACOE, and on guidance contained in the US Environmental Protection Agency Region 6's Mitigation Circuit Rider Program (2001). Types of field data collected from each site dealing with the wetland ecological assessment (WEA) of the project site is listed in Appendix B.

[3] Projects that were dropped were California Oak Creek, Farrell Parcel, and Sheldon North Subdivision.

[4] GPS coordinates were suspected of being inaccurate for sites 11, 12, 13, 14, 15, 16 (?), 17, and 18, so locations for these sites are estimated.

2.2. Field methods

The WEA Team consisted of four full-time members who assessed all 20 projects. These consisted of an ornithologist/naturalist, an invertebrate specialist/naturalist, and two wetland mitigation regulators—one from the SFB CRWQCB and the other from the US ACOE. A fifth member included a professional botanist who evaluated eight of the 20 projects. A student botanist also helped assess two projects in the field. A zoologist with wetland regulatory experience served as an outside evaluator and conducted three assessments in isolation (i.e. without communicating with the WEA Team) in order to compare scores. Additional staff from the SFB CRWQCB, US ACOE, and the San Francisco Estuary Institute provided various degrees of expertise and experience. Assessments were conducted between March 18, 2003 and May 5, 2003 and generally took between two to four hours for each site depending on size and site complexity.

Project information was reviewed by some of the team members before the site visit. In the field, attempts were made to view 100% of the site by walking, driving, or seeing it from an upland vantage point. At least 50% of the sites were walked in most cases. If sites were larger than 100 acres, they were assessed from more than one point.

Project evaluations consisted of the WEA for ecological wetland function as well as a determination of permit compliance. Ecological assessments included vegetation, bird, and invertebrate surveys with notations made for observations of mammals, amphibians, reptiles, fish, or any sign of those wildlife groups. The project team discussed scoring rationale for each category until consensus was reached. The following methodologies were used to assess invertebrates, birds, and vegetation in the project areas:

- *Invertebrates* were collected in vegetation along a transect using timed insect sweeps, with an insect net passed over the same area twice. For aquatic areas, five sweeps were taken with a D-ring net. In both cases invertebrates were identified, tallied, and released. Identification was made to the lowest practical taxonomic level, which was to genus or species for some organisms and to order or family for others.
- *Birds* were detected by sound or sight with binoculars or with a spotting scope and the species was recorded.
- *Vegetation* was described from assessment points with maximum visibility as well as from transects run through project areas that provided information on species, dominants, patterns, vigor, and invasive species. The surrounding area was also assessed. All team members contributed to the evaluation based on what was expected to be and what was actually in the site. When the professional botanist assessed a site, he used his own rating system along with the botanical site

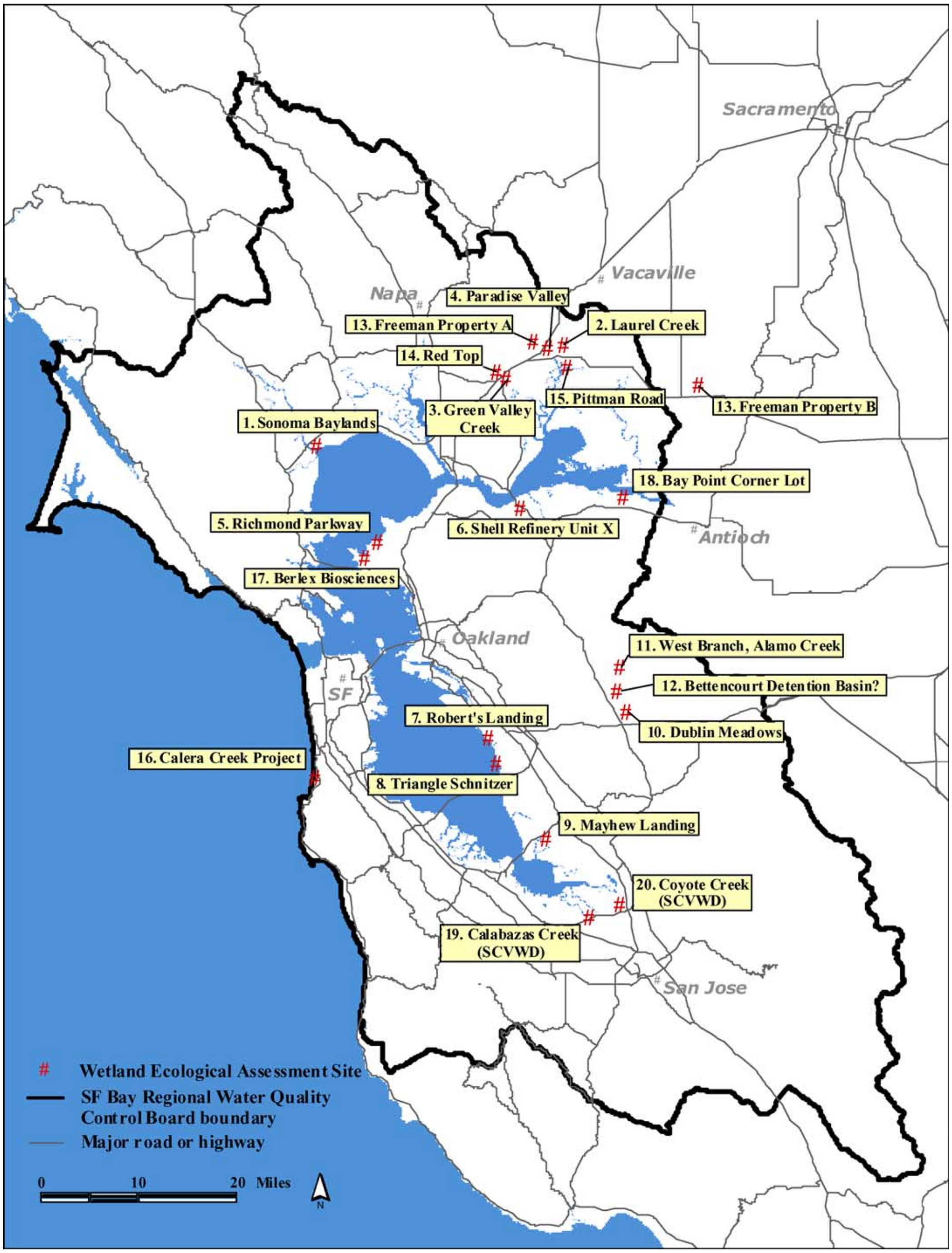

Fig. 1. Wetland ecological and compliance assessments in the San Francisco Bay Region, California (Spring 2003), locations approximate.

evaluations for each of the eight evaluations that he made (BMP Ecosciences, 2003). The rating system and evaluations for vegetation along with the detailed information on birds and invertebrates have been incorporated into the 20 site summaries found in the complete report for this project at http://www.swrcb.ca.gov/rwqcb2/Download.htm (in 'Available Documents' under 'Wetland Assessments'). The vegetation at the other sites was evaluated by the remaining team members (particularly the vegetation transect data contributed by the invertebrate specialist).

Other summary information on each individual site was provided for the remaining species groups. Note, however, that specific surveys were not conducted for mammals, fish, amphibians, and reptiles, which were noted only incidentally in the surveys conducted for birds, invertebrates, and plants.

Table 1
Wetland Projects visited and/or assessed in spring 2003

Site name and number	Date visited (2003)
Sonoma Baylands	March 18
City of Fairfield, Laurel Creek	March 18
Green Valley Creek	March 19
Paradise Valley	March 19
Richmond Parkway	March 20
Shell Refinery Unit X	March 20
Robert's Landing (aka Heron Bay or Citation Homes)	March 27
Triangle Schnitzer	March 27
Mayhew Landing	March 27
Dublin Meadows	March 28
West Branch Alamo Creek	March 28
Bettencourt Detention Basin	March 28
Fleeman Property (aka Peabody Road)	April 7
Red Top	April 7
Pittman Road	April 7
Calera Creek Project (Pacifica Wastewater Treatment Plant)	April 9
Berlex Biosciences	April 10
Bay Point Corner Lot (aka Allied Signal or General Chemical)	April 10
Calabazas Creek (Santa Clara Valley Water District)	May 5
Coyote Creek (SCVWD)	May 5

3. Results

Table 2 lists the projects evaluated by size and provides information on predominant habitat type, WEA score, Compliance score, and, if available, a Botanical score (labeled 'BMP Vegetation' score after the project consultant). Projects ranged in size from 0.1 to about 300 acres and included seven riparian, six tidal, three perennial freshwater (one not assessed in field), one vernal pool (consisting of two actual project sites under one permit application), and three other seasonal wetlands (one not assessed in field). Comparisons should generally be made only between wetlands of the same type. Some projects had more than one type of wetland, in which case the larger type was evaluated. Wetland restoration and creation were counted as net gains in wetland extent. However, enhancement and preservation were not counted, since most regulatory agencies do not generally consider these actions, whatever their desirability may be, as increasing the existing wetland base.

The following scoring techniques were used (See Appendix B for a complete description of the metrics used for WEA and Botanical scores; the criteria used for Compliance scores are described below in Table 4):

- WEA scores were rated from 15 (high) to 1 (low). Five metrics were scored each with a possible high score of 3 points (wildlife habitat, vegetation, hydrology, buffer, surrounding land use);
- Compliance scores were rated as 5 (high) to 0 (low);
- Botanical scores (BMP) were rated (for eight of the 20 projects) from 3 (high) to 1 (low). Three categories were used to evaluate vegetation (composition, structure, and re-establishment).

The average WEA score for all projects was 10.1, with a range of individual scores from 6.9 to 13.1.[5] All of the five sites that scored the highest overall in the WEA also scored the highest in hydrology (score of 3)—four of those sites are tidal sites and one is a perennial stream. Hydrology scores ranged from 1.5 at a site where check dams supporting wetlands had failed, to 3.0. Wildlife scores were generally high, with 12 of the 18 sites evaluated scoring 2 or above. Only Sonoma Baylands received a score of 3.0 and this score could be revised downward at the end of the 20-year monitoring period if there is inadequate habitat for the endangered California clapper rail (*Rallus longirostris obsoletus*). Vegetation scores were somewhat higher overall, although no site received a score above 2.9. The highest score for surrounding land use was again achieved by Sonoma Baylands which received a 2.6.

The three scores provided by the outside evaluator were generally in agreement with those reached by the WEA Team by consensus. Scores were as follows with the WEA Team listed first, followed by the outside evaluator: Richmond Parkway—12.3 and 12.2; Triangle Schnitzer—10.9 and 9.7; and Calera Creek 13.1 and 12.0. Scoring differences at Triangle Schnitzer were primarily based on buffers and surrounding land use, and at Calera Creek were based on buffers and hydrology. Though there was not more than a 10% difference between the outside evaluator and the WEA Team on any of the three projects, definitions of adequate buffers, surrounding land use and reliable hydrology should be expanded and re-tested for future assessments.

In addition to WEA scores, Table 2 also lists compliance scores along with comments about the projects' performance in relation to its permit requirements. Compliance is based mainly on meeting the performance criteria contained in the permit and on turning in timely (usually annual) monitoring reports. Table 3 shows the number of projects by size category that met or failed various levels of compliance.

In general, compliance for 17 of the 18 projects evaluated and ranked was good. (Of the original 20, impacts to Mayhews Landing were avoided so the mitigation project never took place, and Bettencourt detention basin could not be evaluated in the field due to a lack of clear project performance criteria). Only one very small project permitted by the US ACOE apparently failed to be completed (at the Pittman Road site, 0.2 acres was supposed to be restored and was not). Several of the larger projects are

[5] Two sites, Sonoma Baylands and Dublin Meadows, were reconsidered after the site visits because further investigation indicated that scores for wetland function or wetland permit compliance should be reduced from the score given at the site visit. The original scores are used in this analysis, but the suggested revisions are included in Table 2 for instructive purposes.

Table 2
Project Size, Wetland Evaluation Assessments (WEA) Scores, and Compliance Scores (Spring 2003)

WEA #[a]	Major habitat type[b]	Project name	Acres lost	Acres created, restored, or enhanced	C, R, E, or P[c]	BMP plant scores: project[d]	BMP plant scores: context[d]	WEA wildlife	WEA vegetation	WEA buffer	WEA hydrology	WEA surrounding land use	Total WEA score[e]	Compliance score[f]	Commnets on compliance[g]	Gain (+)/ loss (−) in acres[h]	Additional enhancement
0–2 Acres																	
17	PF	Berlex Biosciences	0.07	0.01	C			1.5	2.9	1.5	3	2.1	11	5	SPC	0 (A)	
15	PF	Pittman Rd	0.2	0.2	R	1-1-2	1-1-1							0	Project should have happened but was never carried out?	0	−0.2
6	PF	Shell Marsh Unit X	0.7	0.7	C	2-2-2	1-1-1	2	2	1.5	2	1.2	8.7	5	SPC	0 (R)	
2	R	City of Fairfield, Laurel Ck	0.8	1.2	E			1	1.6	1	2	1.5	7.1	3	Performance criteria not successfully met	−0.8	1.3
18	T	Allied Signal (now General Chemical)	1.4	1.4	R			1	2.8	2	3	1	9.8	5	SPC	0 (R)	
12	S	Bettencourt (Camino Tassajara)	1.6	0.2	E			0.5	2.2	1	2	1.2	6.9	1 or NA	NA Assessed only 0.2 of 1.8 acre project	? NA	
19	T	Calabazas Creek (SCVWD Mitigation)	1.9	1.7	C			2	2	2	3	2	11	5	SPC	−0.2	
13A*	VP	Fleeman (On-site Restored)	1.4	0.7	R/C	2-2-2	1-1-1	1.5	2.3	2	2	1.5	9.3	5	SPC (count 13A & 13B as one project)	1.5 (A)	
13B*	VP	Fleeman (off-site created)		1.4		2-2-2	2-2-2	1	2.3	3	2	1.5	9.8	5	SPC	(included under 13A)	
Total																**0.5**	**1.1**

(*continued on next page*)

Table 2 (*continued*)

3–5 Acres																
5	T	Richmond Parkway WEA TEAM	2.6	2.6	C	3-3-3	1-1-1	2	3	2	3	2.2	12.2	4	Was supposed to stop after 5 years or whenever performance criteria were met whichever took longest. SPC	0 (R)	
5		Richmond Pkwy (outside evaluator)						2	3	2.6	3	1.7	12.3				
14*	S	Red Top	1.0	C = 0.4 (seasonal); E = 2.2 (riparian)	E/C	2-2-2	1-1-2	1	1.9	2	2	2	8.9	3	Replant non-native trees with trees more approriate to site? PC not completely met	−0.6	2.2
4	R	Paradise valley	3.0	3.1	C			2	2	2	1.5	1.6	9.1	5	SPC	0	
10	R	Dublin meadows	0.1	3.8	E			1.5	2.1	0	3	1.1	7.7	2	Replant some trees and remove exotics?	−0.12	3.8
10		Dublin meadows revised		3.8	E			1.5	1.5	0	3	1.1	7.1				
9	S	Mayhews landing	0.0	0.0	R			NA	NA	NA	NA	NA		NA	Project never happened due to avoidance	NA	
Total																**−0.72**	**6**
6–10 Acres																
8	T	Triangle Schnitzer Marsh* (WEA Team)	1.3	7.0	R	2-2-3	1-1-1	2	2.4	2	2	2.5	10.9	5	SPC (but poor perfmornace criteria)	5.7 (R)	
8		Triangle Schnitzer Marsh* (outside evaluator)						2	2.4	1	2.5	1.8	9.7				

(*continued on next page*)

Table 2 (*continued*)

WEA #[a]	Major habitat type[b]	Project name	Acres lost	Acres created, restored, or enhanced	C, R, E, or P[c]	BMP plant scores: project[d]	BMP plant scores: context[d]	WEA wildlife	WEA vegetation	WEA buffer	WEA hydrology	WEA surrounding land use	Total WEA score[e]	Compliance score[f]	Commnets on compliance[g]	Gain (+)/ loss (−) in acres[h]	Additional enhancement
20*	R	Coyote Creek (SC Valley Water District)	??	7.0				2	2.8	3	3	2.2	13	4	Ongoing but SPC	??	
16	R	Complete Calera Creek Project (or Pacifica WW Trt Plant)	7.1	8.0	R	3-3-2	2-2-2	2.5	2.4	3	3	2.2	13.1	4	MNC but successful so far	0.9 (A)	
16		Calera Ck (Riparian)				3-3-2	2-2-2										
16		Calera Ck (Palustrine)				3-3-3	2-2-2										
16		Calera Ck (outside evaluator)						2.5	2.5	2.5	2	2.5	12				
11	R	West Branch Alamo Creek	1.9	9.2	C			1.5	1.9	0	3	1.8	8.2	5	SPC	7.3 (R)	
3	R	Green Valley Creek	5.4	14.0	C			2.5	1.7	2	2	1.7	9.9	4, PNF	MNC but successful so far	8.6 (A)	
Total																**22.5**	
11–50 Acres																	
>51 Acres																	
1*	T	Sonoma Baylands	56.0	289.0				3	1.5	3	3	2.6	13.1	3	Late with monitoring reports. Most of performance criteria being met but not all. MNC	233 (A)	
1*		Sonoma baylands* revised						2	1.5	3	2	2.6	11.1				

(*continued on next page*)

Table 2 (*continued*)

7*	T	Roberts Landing (com- plete)	13.0	R=44; E=74	R/E			2	2.2	2	2.5	2.2	10.9	4	Late with monitoring report. MNC but successful so far	31 (A)	74 (A)
7*		Robert's landing (triangle)				2-3-3	1-1-2										
7*		Roberts landing (Trojan)				2-3-3	1-1-2										
Total																**264**	**74**

A second occurrence of a project name indicates it was assessed by two different assessment teams. WEA, wetland ecological assessment team's scores; BMP, professional botanist's scores.

[a] WEA, Wetland Ecological Assessment Project (note '*' means project was not randomly selected).

[b] R, riparian; T, tidal; S, seasonal; VP, vernal pool; PF, permanent fresh.

[c] C, created; R, restored; E, enhanced; P, preserved.

[d] BMP Legend: (See Appendix B for complete description.); 3, high; 2, medium; 1, low; C, composition, S, structure, R, re-establishment.

[e] WEA scores added for final total score.

[f] Compliance score: 0, poor; 5, good; PNF, project not finished; note many have question marks because these are only suggested and not final scores.

[g] MC, monitoring completed; SPC, successfully met performance criteria; MNC, monitoring not complete.

[h] Determines net gain/loss in quantity, not quality; R, realized; A, anticipated. Note that gain/loss is based on restoration and creation, not on enhancement.

still young and some took longer than expected to begin construction. Most projects are completed and successful or still monitoring but proceeding in the right direction. Consideration should be given to raising the criteria in terms of requiring native species on and surrounding project sites, in order to assure native plant and wildlife diversity for the future.

Table 4 lists the WEA scores by habitat type showing tidal projects as having the highest average scores. Sample size for seasonal (two assessed in field), vernal pools (two assessed in field but part of one project), and perennial fresh (two assessed in field) are generally too small to draw reliable conclusions. Table 5 provides additional summary data for birds indicating extremely high use by waterbirds, shorebirds, and landbirds at or near the Sonoma Baylands site (#1 on Table 5); high use at Robert's Landing (#7) by a diversity of bird groups; high use by landbirds at Dublin Meadows (#10), Calera Creek (#16) and, to a lesser extent at Calabazas Creek (#19) and Coyote Creek (#20).

Summary data for invertebrates proved to be too variable to analyze by site for this report but general types of invertebrates observed are listed by order in Table 6. These organisms are typical for the habitats and season surveyed. The cool wet March probably reduced the number of active terrestrial insects observed during that month. Larger invertebrate samples taken in the future at specified times of the year and following standardized protocols could contribute to valuable data sets for wetlands such as those that are currently being collected for California's wadeable streams. Thus, Plecoptera and Ephemeroptera found in Table 6 generally indicate high water quality, others such as Diptera and Coleoptera indicate medium water quality, and Cladocera generally indicates low water quality (Harrington and Born, 2000).[6]

Most projects were providing some ecological wetland function and were in compliance with their permits. Increases in the net gain of wetlands came mostly from the larger projects. Overall the projects reviewed for this study suggest that unlike some areas of the country or the state where the no net loss of wetlands is generally not occurring (e.g. Kentula et al., 1992; Race and Fonseca, 1996; National Research Council, 2001; Sudol and Ambrose, 2002), the San Francisco Bay Region is increasing its wetland base by emphasizing avoidance and by allowing more and larger wetland restoration projects (note that these are not always projects that entail

[6] These correspondences were derived from creek and stream studies, and the WEA is not dogmatically wedded to the use of invertebrates for measuring the health of other wetland types absent further study showing the reliability of these correspondences. State-wide surface water monitoring in California creeks and streams includes benthic macroinvertebrate collections analyzed according to protocols developed by the California Department of Fish and Game (Harrington and Born, 2000) and the US EPA (Barbour et al., 1999). The use of invertebrates as indicators in other wetland types in California is less well-developed.

Table 3
Number of projects by compliance score in each size category

	Completed and successfully met performance criteria (5=a typical score)	Not completed but proceeding in right direction; or completed but missed some monitoring reports (4=a typical score)	Completed but did not meet all criteria (3=a typical score)	Not completed and performance criteria poor so far and/or inadequate monitoring reports: (3 or 2=a typical score)	Failed (no project; inadequate monitoring reports; or failure of major success criteria (1 or 0= a typical score)
0–2 Acres	5 Projects[a,b]		1 Project		1 Project
3–5 Acres[c]	1 Project	1 Project	1 Project	1 Project	
6–10 Acres	2 Projects	3 Projects			
11–50 Acres					
>51 Acres		1 Project		1 Project	
Total	8	5	2	2	1

[a] Bettencourt Detention Basin was not scored because it is still under review by the US ACOE.
[b] Note both Fleeman Project Vernal Pools counted as one project.
[c] Note that one project in this category never happened because wetland impacts were avoided.

mitigation). The true test will be the monitoring and assessment of these projects over the coming decades to determine if they continue to produce viable and ecologically diverse wetland systems.

The sample size of 20 divided between five wetland types is too small to draw any broad conclusions about its validity for assessing wetland function and compliance generally. However, there seem to be certain patterns and associated implications among wetland types, arising from the assessments that are worthy of note.

First, as a group, the six tidal projects in this study had the highest average for wetland ecological success. All of these tidal projects were located between or adjacent to existing tidal marsh sites and therefore served to expand or connect already successful natural sites. Point Richmond, Bay Point Corner Lot, Triangle Schnitzer, and Robert's Landing all scored high in a relatively short period of time, in part as a result of their proximity to established natural wetland sites. This is consistent with findings that tidal marsh restoration sites are sometimes easier to restore or create than other wetland types when wave energy is low (e.g. NRC 2001, Kusler and Kentula, 1990). On the other hand, these tidal marshes may be successful because of their contiguity with existing marshes or because of the large amounts of time and money put toward the design and construction of these mitigation projects.

Second, in regard to the seven riparian projects assessed, we found that where a mitigation site is small and located in a highly developed urban area with multi or single family housing on small lots, there is little room for adequate buffers to protect the creek. Without space wide enough to allow dense or even partial riparian canopies, the absence of shade is likely to exclude diverse invertebrate communities and allow, instead, dense stands of cattails. While these projects undoubtedly have value from a local or neighborhood perspective, they have little value from an ecological perspective. We therefore determined that large size is a determining factor in the success of most of these projects, and in Table 2, we have accordingly grouped them by size. Based on the projects we assessed, the larger the riparian project, the higher it was ranked. Further testing is required in order to validate these preliminary results.

And finally, only two vernal pools (under one permit) were evaluated and the same general conclusion could be drawn about those, i.e. they met permit conditions but their success was limited by small size and relative isolation. One was located in a small field surrounded by roads and houses, and the other was in a dry agricultural area surrounded by

Table 4
WEA scores by habitat type (highest possible score =15)

	Riparian (# =7)	Tidal (# =6)	Seasonal (# 3)[a]	Vernal pool (# =1)[b]	Permanent fresh (# =3)[a]
Number of sites with scores between:					
0–8	2		1		
8.1–11.9	3	4	1	1	2
12–15	2	2			
Average WEA score for habitat type	9.7	11.5	7.9	9.6	9.8
Score converted to 0–1.0 scale:	0.64	0.77	0.53	0.64	0.65

Note that some projects have more than one habitat type; some projects combine different areas under the same project; and two projects were not assessed because they never happened.
[a] One project in this group was not assessed.
[b] One mitigation permit for this habitat type had two different projects that were assessed separately.

Table 5
Numbers of bird species observed at each site (or known to occur) grouped by type (for site names see Table 1)

WAE site #	Spp.[a]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Date		March												April						May	
		18	18	19	19	20	20	20	27	27	28	28	30	07	07	07	09	10	10	05	05
Waterbirds (grebes, pelicans, ardeids, geese, and ducks)	25	19	0	1	1	0	0	5	2	1	2	0	0	1	0	0	2	0	1	6	1
Raptors	10	6	0	5	0	2	0	3	1	1	2	3	2	1	1	0	3	1	1	2	1
Gallinaceous birds (quail and rails)	7	3	0	0	0	2	0	2	1	0	0	1	0	0	0	0	0	0	0	1	0
Shorebirds	19	18	0	0	0	1	0	6	1	2	0	0	0	3	0	0	1	0	1	3	0
Gulls and Terns	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Landbirds (doves thru goldfinches)	81	34	11	13	9	3	4	11	3	5	21	11	6	11	13	0	21	12	9	12	14
Introduced birds	4	1	0	0	0	0	0	0	0	0	2	0	0	1	0	0	1	0	1	1	0
Total species[b]	156	84	11	19	10	8	4	27	8	9	27	15	8	17	14	0	28	13	13	26	16

[a] Spp, number of species.
[b] These totals include species observed on or adjacent to site or for which there are known occurrences.

Table 6
Selected invertebrates found at San Francisco Bay sites for Wetland Assessments in Spring 2003

Order	Common name
Acarina	Water mite
Actiniaria	Anemone
Amphipod	Amphipod
Arachnida	Ground spider; tick
Basommatophora	Mouse-eared marsh snail
Cladocera	Water flea
Coleoptera	Scavenger water beetle; click beetle; lady-bird beetle; brown leatherwing; predaceous water beetle; flower beetle
Conchostraca	Clam shrimp
Cyclopoida	Copepod
Decapoda	Lined shore crab
Dermaptera	European earwig
Diptera	Black fly larvae; robber fly; louse fly; midge; cranefly; brine fly; shorefly; hover fly; mosquito
Ephemeroptera	Mayfly
Geophilia	Slug
Hemiptera	Waterboatman; true bug; spittlebug; black grass bug; water strider; green adult; aphid; stink bug
Homoptera	Leaf hopper
Hymenoptera	Bumble bee; ant; wasp; native bee
Isopoda	Isopods
Lepidoptera	Buckeye; monarch; pygmy blue; hairstreak; paradise blue; cabbage white; alfalfa sulfur; California ringlet; moths
Myoida	Soft shell clam
Mytiloida	Bay mussel
Neogastorpoda	Eastern mud snail
Neuroptera	Snakefly
Odonata	Damselfly; dragon fly
Orthoptera	Cricket
Ostreidae	Olympic oyster
Phasmatodea	Walking stick
Plecoptera	Stonefly
Thysanoptera	Thrip
Veneroida	Gem clam shell; Japanese littleneck clam

For complete list by site and family, genus, or species, see http://www.swrcb.ca.gov/rwqcb2/Download.htm (in Available Documents, Wetland Assessments).

non-native grasses. They were 'successful' in terms of establishing vernal pool species (both native and non-native) but they might be better situated in a larger watershed complete with adequate drainage areas, swales, and native grasslands. The project applicants in cases like these choose the least expensive and most practical sites for these mitigation projects. A coordinated effort among interested parties with a regional landscape perspective could combine resources, help locate projects in a regionally rational context, help control invasive species, conduct experiments to inform flexible management practices, and provide long-term monitoring which could extend beyond the typical 5-year period for small projects.

Again, as stated above the sample size is small for the wetland types assessed here, so any inferences based on the results of this project should be considered only as hypotheses that could be further tested. These include (1) tidal marsh sites have higher success rates than other wetland types; (2) the success of riparian sites will depend on the size and quality of both the actual site and its buffer, and (3) the ultimate success of all restoration sites will depend on both adequate hydrology and the control of invasive species. An experimental protocol that could test these hypotheses and the validity of the assessment method should follow the following procedures: first, further test these results by providing more external evaluators to provide a higher degree of confidence when comparing WEA scores; second, conduct the WEA at the same sites during different seasons; third, assess the sites using other rapid assessment methods such as the WRAP, the Rapid Impact Assessment Method (RIAM), or the California Rapid Assessment Method (CRAM); and finally, conduct intensive biological, hydrological, and water quality surveys at the assessed sites over a longer period (preferably years) to determine whether sites assessed rapidly actually maintain their scores over time.

4. Conclusions/discussion

The key elements required to evaluate wetland restoration or mitigation projects are simple and have been noted many times before. Those are: an adequate tracking system, a standardized methodology, a 'science-based' methodology, and funds to pay either regulatory staff or consultants for evaluation time. The methodology can be selected from existing wetland assessment techniques, or newly designed by the agency carrying out the assessments or by paid consultants. What is important is that results accurately reflect site conditions and that steps are included in the program design that will test the method for repeatability by different users. To carry out a successful program data should be statistically analyzed to determine whether there is acceptable or unacceptable variation between samples. This requires that sites be representative of the population of wetland mitigation or restoration projects, that they be stratified by wetland type, age, and size, and that there is a large enough sample to develop appropriate statistics. In the beginning, efforts should be made to develop the appropriate databases and to test methods for repeatability. This can be done with fairly subjective metrics or with highly quantitative indices of biological integrity, since it may be that subjective metrics, an outcome of professional judgment, may be more nuanced and reliable than highly quantitative indices. Once these steps have been accomplished, sites can be evaluated statistically providing a more meaningful analysis for the San Francisco Bay Region, the state of California, or the nation as a whole.

Of the 120 projects in the SFB CRWQCB database that were permitted between 1988 and 1995, more than half were small projects of less than one acre. Since the mid-1990s, many very large projects–some over 1000 acres—have received permits to restore wetlands, as either compensatory mitigation projects requiring an increase in wetland acreage to adequately mitigate for anticipated temporal and permanent impacts, or simply as restoration projects seeking to return altered sites to their pre-existing wetland condition. While the small projects add up and can be important, they can also be a drain on scarce resources in terms of permitting and follow-up monitoring. Consideration should be given to combining these small compensatory wetland mitigation projects whenever possible into regionally integrated mitigation banks. If cities, counties, regional, state, and federal agencies select wetland restoration sites, future compensatory mitigation projects can be directed toward those larger, regionally integrated sites and economies of scale can be realized in their tracking and evaluation. Connecting new wetland habitats to old ones and combining mitigation sites can increase project success and provide relatively less expensive means to maintain native species habitats and provide the added value inherent in larger wetlands. For example, densities of California clapper rails, a federal and state endangered species, are positively correlated to larger marsh areas (Collins et al., 1994); this area/density relationship has also been found for the California black rail (Evens and Nur, 2002), another federal and state listed ('threatened') tidal marsh-dependent species.

Rapid assessments can only capture a few hours at any site and are therefore likely to under or over-estimate the importance of a site because they miss diurnal, seasonal, annual, or decennial variation. Rapid assessments should not be thought of as a substitute for longer and more thorough surveys that are typically found in mitigation monitoring reports, environmental site assessments, or scientific studies. Every attempt should be made to review all available pertinent information about the site before conducting the evaluation, and the assessors should be aware of the regional and policy contexts. This is especially true of large projects with lengthy monitoring periods.

For example, Sonoma Baylands, the largest site assessed, scored high on the day of assessment for shorebird and waterfowl use. It did not score high that day for the California clapper rail and the salt marsh harvest mouse (*Reithrodontomys raviventris*). These results of a mere half day, however, reflect a broader debate among regulators and scientists familiar with the site over its ability to provide habitat for these species. Restoration goals for California clapper rails and salt marsh harvest mice were not met in the short term (6 years since construction), however, the long-term potential for these species is an open question, and the monitoring period is 20 years. Thus, a policy decision must still be made by regulators and interested members of the public whether to allow the site to continue to develop slowly, which benefits shorebirds and waterfowl, or to speed up tidal creek evolution by widening the channels in order to ultimately create high quality habitat for California clapper rails and salt marsh harvest mice.[7]

It should also be noted that the current endeavor to restore tidal marshes is fairly recent, and it is too early in most places for tidal marsh restoration projects to be declared successful or not. Indeed, the larger projects in this study still have an additional 5–10 years before a determination of success is required. Progress so far is variable depending on the amount of available sediment, wind/wave erosion, degree of subsidence, and tidal exchange through channels.[8] Because of these ambiguities arising from temporally limited assessments, assessors by necessity must focus on the *potential* of the site to accommodate healthy food webs and special status species. This practice should be incorporated into any formal assessment method used, so that credit is given to a site for the appearance of the structural complexity required for the survival of terrestrial and aquatic animals and plants. It is a good idea, therefore, to include in the final evaluation species *expected* at a site, based on professional judgment, in addition to those actually observed at the time of the assessment. Also, surveys should always include vegetation, and should be rotated between major animal species groups (birds, mammals, amphibians and reptiles, fish, and invertebrates) to assure adequate representation of all members of the food web. Special attention, however, should be given to 'keystone' species, i.e. high trophic-level species integral to ecosystem function.

Other cautions regarding rapid assessment techniques include an emphasis on the seasonality of habitat use by biological species. In the San Francisco Bay Region, some migratory birds may not be present until May or may occur sporadically; some plants will flower in early spring but wetland species will be better identified in summer; terrestrial invertebrates may be late if spring rains are late (or not be present at all under drought conditions), but aquatic invertebrates and amphibians may not be present after May. Annual precipitation can vary widely, so habitat use can vary widely even by the same species. Generally the best time for wetland evaluations will be in the spring or early summer.

Finally, it cannot be overemphasized that a rapid assessment method cannot in itself compensate for lack of experience or knowledge in the assessor. These methods can efficiently focus attention on the pertinent factors, but the assessor must be capable of recognizing and evaluating these factors. Thus, our survey was conducted by a highly qualified and experienced team of scientists and regulators. Nonetheless, any deficiency in knowledge and experience can be offset by adequate preparation and research on all available information on the project before the assessor goes into the field. In this regard, an adequate data base, which incorporates the important and pertinent features of the project, is essential to preserve the 'rapidity' of any assessment method used in the field. Future efforts should be put toward determining whether adequate databases and pre-evaluation research on the site, combined with trainings on how to evaluate wetland projects, can provide results similar to those achieved by the experienced team of scientists and regulators.

5. Recommendations[9]

1. Use any rapid assessment method with caution. It is important to gather background materials on the site including design plans, monitoring reports, etc. At the very least, the goals of the project need to be known before an assessment is done. The following steps should be followed before rapidly assessing projects and selecting a rapid assessment method for regional or state-wide use:
   (a) have an appropriate database in place to enter all pertinent site information;
   (b) review all documents relating to the site and its surrounding areas;
   (c) conduct rapid assessments with a team of local experts on vegetation and wildlife;
   (d) provide follow-up surveys at different seasons for at least 1 year with equal sampling within each season to determine the effects of seasonality on the assessment procedures, noting especially the occurrence of different species (especially target species listed by wildlife agencies as being endangered, threatened, or merely sensitive to habitat alterations);
   (e) have different assessors rate the same site to determine if results are repeatable; and
   (f) provide formal training on the proper use of whatever rapid assessment method is selected (e.g. WEA, WRAP, RIAM, CRAM).
2. A program should be put in place to require that mitigation and restoration sites set aside at least 30% of project funds to allow meaningful monitoring and assessment of projects. Required resources should fund a state-wide wetland monitoring program that would provide standardized assessment tools, guidelines for statistical analysis, and quality assurance for data collection. Data could then be collected on each project with specific monitoring requirements for each project.

[7] Some project evaluators have claimed that it could be too late for the tidal marsh channels to develop at the Sonoma Baylands site because the soil may be too consolidated and the vegetation may become too entrenched for the channels to form. Others have claimed that, while the tidal channels were initially slow to enlarge, they have indeed begun to rapidly erode, and should eventually meet the project performance criteria which require tidal marsh hydrology, vegetation, and wildlife.

[8] The apparent success of tidal marshes arising from naturally breached levees cannot provide an accurate measure of success for artificial restoration projects (Williams and Orr, 2001).

[9] These recommendations arise not only from the narrow experience of this project, but also from a broader regulatory and scientific experience of which this project is sometimes illustrative.

3. Agencies with responsibilities for restoring wetlands (either as regulators or purchasers) should put an adequate amount of resources toward tracking and monitoring those projects. This would require: (a) the proper information in a database; (b) reading and reviewing all pertinent documents related to the site; and (c) assessing the site in the field. Determining the appropriate number of projects for each full-time equivalent will depend on whether or not regulators handle both permits and follow-up, and whether outside organizations or consulting firms handle databases, GIS, and monitoring (and how well this is done).It is preferable to keep up with the progress of restoration sites in a timely fashion, i.e. annually, since the first 5 years of a restoration project is the most critical time for failure. If this is impossible due to limited staff or funding, the effort can be made at 5-year intervals at a minimum, but this could lead to a high number of failures.
4. A central agency should manage data and track the progress of mitigation or restoration sites. Project locations, permit application information, and entire monitoring reports can be put on websites and easily accessed (e.g. the Wetland Tracker managed by the San Francisco Estuary Institute). All information required for later review could be put in a single file for that project. This would include detailed diagrams of the locations of plantings. Some of these can never be found without the original project manager present. Clear visuals are needed in addition to detailed descriptions, latitude/longitude, or other GPS data using standardized GPS coordinate systems. Note that GPS data sometimes requires confirmation and is not always correct.
5. Appendices A and B has the basic elements that should be included in a mitigation or restoration project database for later determinations of permit compliance and ecological site assessments.
6. Develop region-wide guidance for removal of aggressive non-native species. It is counterproductive for agencies to require removal of exotics in some projects but not others or in areas surrounded by source populations. Project applicants and their contractors should be required to coordinate their efforts with counties, cities, state, and federal agencies to remove those species that could threaten the life or the integrity of the restoration project. Such coordination would enhance the regional and site-specific efficacy of control projects.
7. Encourage mitigation banks or regional or local efforts that combine resources and responsibilities for the site. For example, it is clear from our assessments that non-native invasive species are a major threat to most mitigation or restoration sites. While tidal wetland habitats may be more protected from invasive species due to inundation and salinity than other wetland types, even their transition areas and upland borders (important refugial habitats for several listed species) appear to be dominated by aggressive non-natives. Cost sharing and regional coordination to eradicate aggressive non-native species could be an effective means of ridding the region of troublesome exotics.
8. Test the validity and repeatability of the chosen assessment method. Future validation of the WEA or any other wetland assessment methods should use several outside evaluators to test the results and to highlight potential strengths and weaknesses of the methods used. Appropriate professionals should include a zoologist, botanist, and hydrologist. Multivariant analysis should be conducted to ensure that all variables are independent of each other and that two variables are not being measured separately when in fact they behave as one variable.
9. The WRAP included an additional metric that was not included in the WEAs conducted for this project because, as stated in the WRAP report, evaluating water quality without a long-term data set makes it very difficult to infer water quality conditions for a site. However, the WRAP uses a water quality metric that infers constituents such as nutrients, some metals, biological oxygen demand, and total suspended sediments from land use. The water quality metric should be further tested in the San Francisco Region and others since it could be a valuable addition to the suite of metrics in the assessment methodology.
10. Mitigation sites should monitor for a minimum of 5 years or until performance criteria are met, whichever is longest. Letters by project proponents stating that the performance criteria have been met early should not excuse monitoring for at least 5 years. This should assure that aggressive species are eradicated both within and surrounding the mitigation site, thus giving the site a good chance to develop a strong native species community.
11. Temporal losses of wetland values should be included when determining mitigation amounts.
12. Performance criteria should require plant species native to the site or to local reference areas, not just native to the area or state.
13. Absolute cover of vegetation, rather than relative cover, should be used to clearly represent the structure of the restored vegetation.
14. Projects that are isolated or at some significant distance from propagule sources should not rely solely on natural dispersal to determine species composition.
15. Cover and abundance data from non-native wetland plants (e.g. *Lolium* sp. in California) should not be lumped together with data from native wetland species. This obscures project values and works against higher standards needed to ensure proper function, structure and wildlife use. Performance standards will also need to recognize this distinction.
16. Control of non-native invasives is a long-term obligation of the project proponent and must be enforced.

17. Management of the immediate project context, including control of noxious weeds, should be part of the regulatory agreement, especially if mitigating for wildlife values.

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APPENDIX I (A). Project Compliance Form

Complete Before Site Visit:

PROJECT NAME:
PERMITTEE:
PERMIT DATE AT U.S. ACOE:
PERMIT DATE AT SFB CRWQCB:
CORPS & SFB CRWQCB PROJECT MANAGERS:
CONSULTANT:
U.S. ACOE FILE NO.:
SFB CRWQCB FILE NO.:
RESPONSIBLE PARTY & CONTACT INFORMATION:

Impacted Project Information:

PROJECT LOCATION (include Lat/Longs, Geographic Positioning System [GPS], aerial photos, street directions,and/or site diagrams or figures):
PROJECT SIZE:
WETLAND TYPE IMPACTED:

Mitigation Project Information:

COMPENSATORY RESTORATION/MITIGATION TYPE:
PROJECT SIZE:
PROJECT DESCRIPTION:
PROJECT GOALS:
YEARS OF REQUIRED MONITORING:
YEARS OF MONITORING COMPLETED:
MONITORING START DATE:
PERFORMANCE CRITERIA:

Complete At Site After Project Evaluated and Rapid Surveys Conducted:

WETLAND ASSESSORS:
WETLAND ASSESSMENT DATE & TIME:
AGE OF PROJECT:
WETLAND ASSESSMENT METHOD USED [e.g., Wetland Ecological Assessment (WEA) which includes Biological Rating Done by BMP Ecosciences; California Rapid Assessment Method (CRAM) when it has been tested and approved; or Wetland Rapid Assessment Procedure (WRAP)]. Note that a form combining the major features in the WEA/BMP/WRAP methods is provided below:

- Field Methods (Standard metrics including hydrology, wildlife habitat, vegetation structure, buffers, surrounding land use. Also note surveys, if any, for plants, birds, mammals, amphibians, reptiles, fish, or invertebrates):
- Site Description:
- Site Score:

PERMIT COMPLIANCE (if a regulatory project):
OVERALL WETLAND GAIN OR LOSS EXPECTED TO RESULT FROM THIS PROJECT:
SITE EVALUATION:

- Do the wetlands appear to be developing as planned?
- Were project goals met?
- Is the project in compliance with its permit?
- What ecological values does the site provide?

RECOMMENDATIONS:

For COMBINED WEA, BMP, & WRAP METHODS, See APPENDIX I(B).

APPENDIX I (B): Wetland Assessment Form (WEA) for San Francisco Bay Projects

[Adapted from South Florida's Wetland Rapid Assessment Form (WRAP) (Miller & Gunsalus. 1999).] Note that this form is expected to continue to evolve as it is used.] Each variable score is summed and then divided by the total possible maximum score for the variables. The final score for each metric is expressed as a number between zero and one, and half increments (0.5) can be added or subtracted based on site characteristics.

1. WILDLIFE UTILIZATION RATING INDEX (WU)

The wildlife utilization variable is a measure of observations and signs (i.e. scat, tracks etc.) of wildlife, primarily wetland dependent species or potential predators. In addition, potential wildlife use through the presence of wildlife food sources, nesting areas, roosting areas, den trees, protective cover and landscape position is also considered. Wildlife includes birds, mammals, fish, amphibians, reptiles, and invertebrates. Previous knowledge of site can be used, but evaluators' level of familiarity of site should be noted on the site assessment form. Select scores based on agreement with some or all of the bulleted items.

Score

EXISTING WETLAND EXHIBITS NO EVIDENCE OF NATIVE WILDLIFE 0

- Existing wetland is heavily impacted.
- No evidence of native wildlife utilization.
- Evidence of non-native wildlife species known to adversely affect native species
- Little or no habitat for native wetland wildlife species.

EXISTING WETLAND EXHIBITS MINIMAL EVIDENCE OF NATIVE WILDLIFE UTILIZATION 1

- Minimal evidence of native wildlife utilization.
- Little habitat for wildlife.
- Sparse or limited adjacent upland food sources.
- Site may be located in residential, industrial or commercial developments with frequent human disturbances.

EXISTING WETLAND EXHIBITS MODERATE EVIDENCE OF NATIVE WILDLIFE UTILIZATION 2

- Moderate evidence of native wildlife use.
- Evidence of aquatic macroinvertebrates, amphibians and/or forage fishes; or small or medium-sized mammals and reptiles (observations, tracks, scat).
- Evidence of use by migrant or resident birds.
- Adequate adjacent upland food sources.
- Adequate protective cover for wildlife (can include woody debris for insects, amphibians).
- Minimal evidence of human disturbance or non-native wildlife known to adversely impact native wildlife species.
- Site known to harbor a special status species

EXISTING WETLAND EXHIBITS STRONG EVIDENCE OF NATIVE WILDLIFE UTILIZATION 3

- Strong evidence of native wildlife utilization including large mammals and reptiles.
- Abundant aquatic macroinvertebrates, amphibians and/or forage fishes (can include woody debris).
- Evidence of use by migrant or resident birds.
- Abundant upland food sources.
- Negligible evidence of human disturbance.
- Abundant habitat for native wildlife within the wetland or adjacent upland.
- Site known to harbor one or more special status species

2. WETLAND DOMINANT VEGETATIVE COVER RATING INDEX

NOTE: Vegetation can be assessed by EITHER the 3 layer approach presented first, OR the BMP approach presented second, OR both approaches.

Objective: The dominant vegetative cover for trees, shrubs, or emergent/herbaceous variable is a measure of the presence, abundance, appropriateness and condition of vegetative cover within the wetland. By definition, aggressive non-native plant species include exotic and nuisance (i.e., invasive) plant species.

Complete assessment each for each layer: (1) Herbaceous [< 1 meter high] (2) Shrub [1-3 meters high] (3) Tree Canopy [> 3 meters high], then average all 3 layers for a final vegetation score. Note these can be weighted based on the judgment of the assessors.

	HERBACEOUS	SHRUB	TREE
% Cover of Aggressive Non-natives: **--High (51% - 100%) ....0** **--Medium (26%-50%) ....1** **--Low (25%-10%) ....2** **--Very low (<10%) 3**			
% Cover of Target Vegetation: **--0-25%..0** **--26-50%.......................................1** **--51-76%......................................2** **--76-100%....................................3**			
Vigor & Reproduction Appropriate to Target Habitat based on Flowers, Foliage, Stems, and Color: **--Mostly dead......................0** **--Unhealthy & little regeneration.........................1** **--Moderate health & regeneration.......................2** **--Excellent condition & regeneration.........................3**			
Structural Diversity Appropriate to Target Habitat: **--Not at all (clearly no progress toward stated goals) ....0** **--Failing (little progress toward stated goals).................................1** **--Acceptable (adequate progress toward stated goals) ....2** **--Appropriate (meeting stated goals)...........3**			
TOTALS			
3 Totals/3 = Final Metric			
Score for Vegetation			

Note the following vegetation scoring can be used with or instead of the 3-Layer Approach outlined in the table above and can also be used with the Buffer Metric (Metric #3):

C-S-R rating system for evaluating the vegetation of restoration projects.
[Source: Pavlik. 2003. Evaluation of the Vegetation of Wetland Restoration Projects in the San Francisco Bay Area, BMP Ecosciences SanFrancisco,CA.]

C = composition (species identity and richness)
1 = mostly exotics (many invasive or noxious) with few CA natives
2 = mostly CA natives that are native to site but some characteristic species missing, **or**
an equal mix of CA natives (some may not be native to the site) and non-natives (some invasive or noxious)
3 = almost all CA natives and native to the site, few if any non-natives, none invasive or noxious

S = structure (architectural complexity)
1 = does not resemble or simulate natural vegetation
2 = does not resemble a reference or template, but generally or vaguely simulates natural vegetation of its kind
3 = closely resembling an appropriate reference site or template, having the complexity and appearance of natural vegetation of its kind

R = re-establishment (population trajectories)
1 = few, if any, native species are reestablishing themselves and non-natives will probably come to dominate under current ecosystem conditions
2 = some native species are reestablishing themselves, others are not and non-natives appear to be taking their place
3 = dominant native species demonstrate re-establishment under current ecosystem conditions

3. ADJACENT BUFFER RATING INDEX

Objective: The adjacent buffer variable is a measure of the area adjacent to the subject wetland and the landscape setting of the wetland. This variable is evaluated based on the adjacent buffer size and the ecological attributes (i.e., cover, food source and roosting areas for wildlife) that this area is providing in association with the wetland that is being assessed. Buffers can include open water, other wetlands, transitional areas, and open space but do not include buildings or well-traveled roads or highways. (Note that credit can be given for more vegetation cover, native species, contiguous habitats, or corridors by adding increments of 0.5 to the score (maximum possible score = 3.0), even if the actual buffer size is more or less than the sizes listed below in the major categories, i.e., <30 ft; between 30 and 300 ft; or >300 ft.)

	Score
NO ADJACENT BUFFER	0

- Buffer non-existent.

ADJACENT BUFFER AVERAGES 30 FEET OR LESS	1

- Less than 25% vegetation cover.
- Not connected or poorly connected to wildlife corridors.
- Greater than 75% of vegetation is invasive exotic or nuisance plant species.

ADJACENT BUFFER AVERAGES GREATER THAN 30 FEET BUT LESS THAN 300 FEET	2

- Contains 25% to 50% vegetation cover.
- Portions connected with contiguous offsite wetland systems, wildlife corridors.
- Between 10%-75% of vegetation is invasive exotic or nuisance plant species.

ADJACENT BUFFER AVERAGES GREATER THAN 300 FEET	3

- Contains >50% vegetation cover.
- Connected to wildlife corridor or contiguous with offsite wetland system or areas that are large enough to support habitat for large mammals, nesting birds, amphibians, or reptiles.
- Less than 10% of vegetation is invasive exotic or nuisance plant species

4. FIELD INDICATORS OF WETLAND/RIPARIAN HYDROLOGY RATING INDEX

Objective: This variable is a measure of the hydrologic regime based on observed field indicators for the subject wetland including hydroperiod duration and magnitude. Wetland hydrology is generally interpreted using <u>vegetative indicators</u>. In addition, the presence of <u>aquatic</u> <u>fauna</u> as well as hydrologic indicators such as <u>lichen lines, algal mats, adventitious roots, basal scarring, drift lines, secondary flow channels, sediment deposition, and water marks are also utilized</u>. Signs of altered hydrology may include <u>encroachment of upland and transitional plant species into the wetland.</u>

	Score
HYDROLOGIC REGIME **FAILING** TO MAINTAIN A VIABLE WETLAND/RIPARIAN SYSTEM.	0

- Hydroperiod inadequate to support target vegetation due to (circle one): (a) too much water or (b) too little water

HYDROLOGIC REGIME **INADEQUATE** TO MAINTAIN A VIABLE WETLAND/RIPARIAN SYSTEM	1

- Hydroperiod minimally supports target vegetation.
- Succession of wetland plant species into transitional/upland plant species.
- Appropriate vegetation stressed or dying from too much or too little water.

HYDROLOGIC REGIME **ADEQUATE** TO MAINTAIN A VIABLE WETLAND/RIPARIAN SYSTEM BUT POTENTIALLY THREATENED	2

- Wetland hydroperiod adequately supports target vegetation but water source is subject to alteration
- Plant community healthy, although there may be some signs of compromised hydrology.

HYDROLOGIC REGIME **ADEQUATE** TO MAINTAIN A VIABLE WETLAND/RIPARIAN SYSTEM AND LIKELY TO REMAIN SO	3

- Hydroperiod adequately supports target vegetation and water source reliable.
- Plants healthy with no stress resulting from an improper hydroperiod.
- Wetland not adjacent to canals, ditches, berms, or other negative impacts to the wetland within the landscape setting.

5. SURROUNDING LAND USE

Estimate amount by percent surrounding site, and multiply by score (add additional categories on field data sheet with appropriate scores)

The scores for land use types are as follows:

LAND USE CATEGORY*	**SCORE**
NATURAL AREAS:	
natural undeveloped areas	3
unimproved pasture / rangeland	2.5
RESIDENTIAL:	
low density residential	2
single-family residential	1.5
multi-family residential	1
COMMERICAL:	
low intensity commercial	2
institutional	2
high intensity commercial	0.5
moderately intensive commercial	1.5
FARMING:	
Agricultural (includes vineyards)	1
dairy and feedlot; horse stables	0
HIGHWAYS	
low volume highway	2
high volume highway	1
OTHER:	
recreational	1.5
golf course	1.5
industrial	1
mining	1

Wetland Ecological Assessment
Field Form

Rapid Assessment Form for SF Bay Wetland Restoration Projects (Spring 2003)		
check one or two:		
Mitigation Project	Existing Condition	Proposed Condition

Project Name:	Corps Application. #:	RWQCB Application #:

Assessment Date:	Evaluators:	Wetland Types(s):

Assessment Time:	Project Age (since breach, fill, completed construction, etc.)

Wetland Acreage (100 acre maximum):	GPS Coordinates:	

Surrounding Land Use Category:

Land Use Category	Score x (% of area) =	Subtotals
	LU Total	

FINAL SCORES:		Total Possible Score:
Wildlife Utilization [WU]		3
Dominant Vegetation Cover (DVC)		3
Layer 1 = herbaceous		[1]
Layer 2 = shrubs		[1]
Layer 3 = trees		[1]
Buffer		3
Wetland Hydrology		3
Land Use Category instead		3
TOTAL FINAL SCORE		15

*for vegetation, average 3 layers

Field Notes:

1. Wildlife Use

2. Wetland Dominant Vegetation Cover

3. Habitat Support/Buffer

4. Hydrology

5. Surrounding Land Use

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