MITIGATION CREDIT DETERMINATION

Eric D. Stein

S. Ca. Coastal Water Research Project

What is a Crediting System?

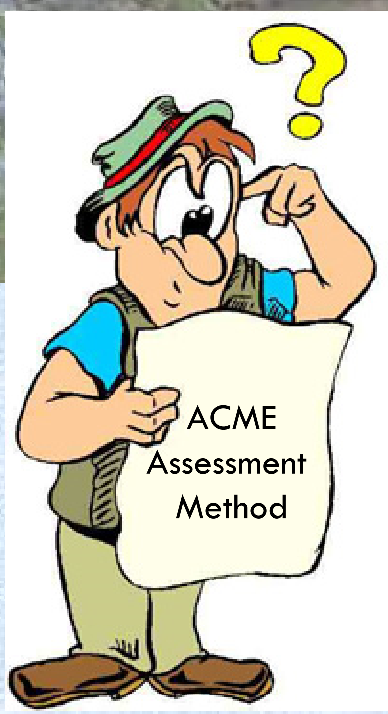
- Common language or currency for informing decisions about tradeoffs between ecological impacts and appropriate compensatory mitigation

Gains over time > losses over time

Impact Sites

Restoration Site

How many credits?



Main Messages for Today

- Primary objective is to determine equitable and appropriate number of credits to compensate for a given impact
- Crediting approach should be consistent with objectives of the mitigation (i.e. should reflect priority functions and services)
- Construct should be transparent and easy to communicate
- Issue of time is the most difficult to address
- Watershed-based solutions will be most effective

Why Do We Need to Worry About This?

2008 Compensatory Mitigation Regulations

§332.2 Definitions

Credit means a unit of measure (e.g., a functional or areal measure or other suitable metric) representing the accrual or attainment of aquatic functions at a compensatory mitigation site. The measure of aquatic functions is based on the resources restored, established, enhanced, or preserved.

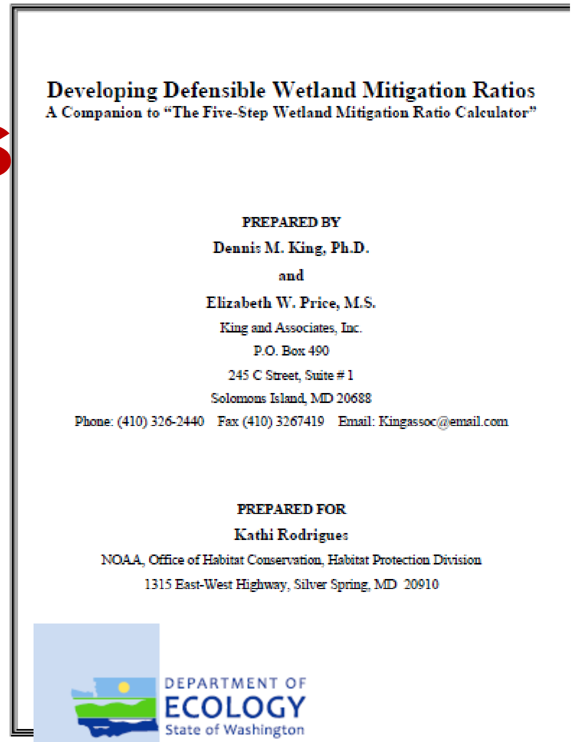
The Rule Does Provide Some Help!

- The district engineer must require a mitigation ratio greater than one-to-one where necessary to account for:
  - method of compensatory mitigation (e.g., preservation)
  - the likelihood of success
  - differences between the functions lost at the impact site and the functions expected to be produced by the mitigation project
  - temporal losses of aquatic resource functions
  - the difficulty of restoring or establishing the desired aquatic resource type and functions
  - distance between the affected aquatic resource and the compensation site.

- The rationale for the required replacement ratio must be documented in the administrative record for the permit action.

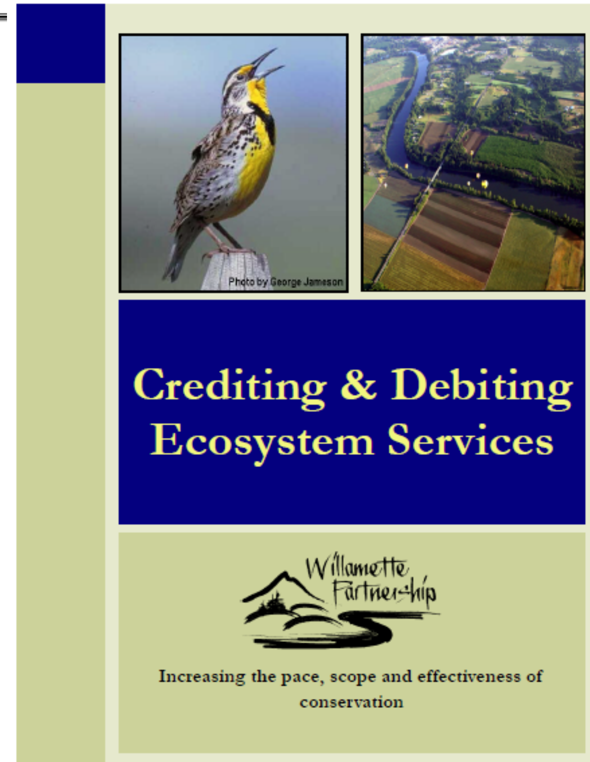
Lots of Options

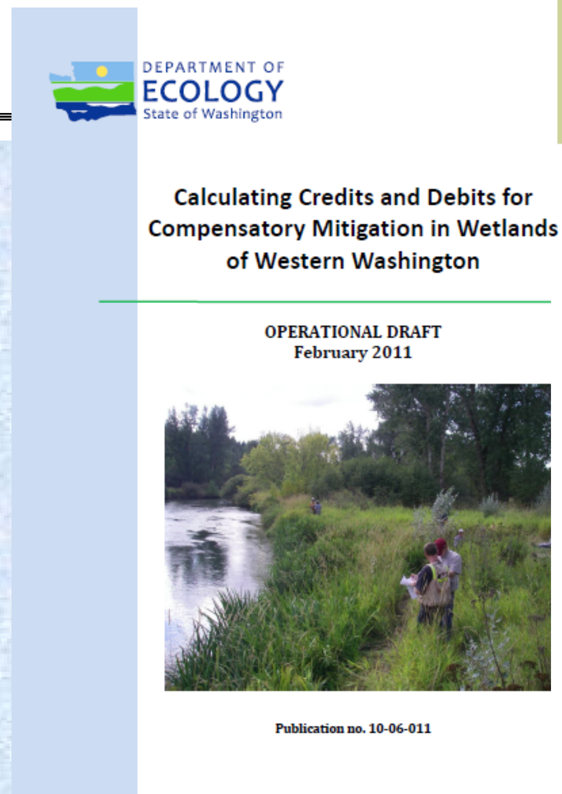
- Basic rule sets or decision trees
- Social values and ecosystem service assessments
- Function or condition assessments


Developing Defensible Wetland Mitigation Ratios
A Companion to "The Five-Step Wetland Mitigation Ratio Calculator"

PREPARED BY
Dennis M. King, Ph.D.
and
Elizabeth W. Price, M.S.
King and Associates, Inc.
P.O. Box 490
245 C Street, Suite # 1
Solomons Island, MD 20688
Phone: (410) 326-2440 Fax (410) 3267419 Email: Kingassoc@email.com

PREPARED FOR
Kathi Rodrigues
NOAA, Office of Habitat Conservation, Habitat Protection Division
1315 East-West Highway, Silver Spring, MD 20910

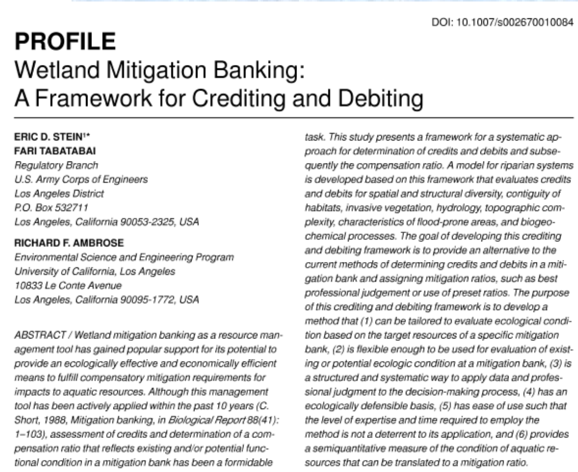




Calculating Credits and Debits for Compensatory Mitigation in Wetlands of Western Washington

OPERATIONAL DRAFT
February 2011

Publication no. 10-06-011


DOI: 10.1007/s002670010084

PROFILE
Wetland Mitigation Banking:
A Framework for Crediting and Debiting

ERIC D. STEIN[1]*
FARI TABATABAI
Regulatory Branch
U.S. Army Corps of Engineers
Los Angeles District
P.O. Box 532711
Los Angeles, California 90053-2325, USA

RICHARD F. AMBROSE
Environmental Science and Engineering Program
University of California, Los Angeles
10833 Le Conte Avenue
Los Angeles, California 90095-1772, USA

ABSTRACT / Wetland mitigation banking as a resource management tool has gained popular support for its potential to provide an ecologically effective and economically efficient means to fulfill compensatory mitigation requirements for impacts to aquatic resources. Although this management tool has been actively applied within the past 10 years (C. Short, 1988, Mitigation banking, in Biological Report 88(41): 1–103), assessment of credits and determination of a compensation ratio that reflects existing and/or potential functional condition in a mitigation bank has been a formidable task. This study presents a framework for a systematic approach for determination of credits and debits and subsequently the compensation ratio. A model for riparian systems is developed based on this framework that evaluates credits and debits for spatial and structural diversity, contiguity of habitats, invasive vegetation, hydrology, topographic complexity, characteristics of flood-prone areas, and biogeochemical processes. The goal of developing this crediting and debiting framework is to provide an alternative to the current methods of determining credits and debits in a mitigation bank and assigning mitigation ratios, such as best professional judgement or use of preset ratios. The purpose of this crediting and debiting framework is to develop a method that (1) can be tailored to evaluate ecological condition based on the target resources of a specific mitigation bank, (2) is flexible enough to be used for evaluation of existing or potential ecologic condition at a mitigation bank, (3) is a structured and systematic way to apply data and professional judgment to the decision-making process, (4) has an ecologically defensible basis, (5) has ease of use such that the level of expertise and time required to employ the method is not a deterrent to its application, and (6) provides a semiquantitative measure of the condition of aquatic resources that can be translated to a mitigation ratio.

Key Considerations

- Applicable to target wetland types
  - Different methods may be necessary for different wetland types
- Applicable to the target geography / service area
- Level of complexity commensurate with resource function or value
- Assesses the functions or services of interest
- Easy to apply and to communicate

Set Ratios Based on Mitigation Type

Figure 5.3x Example Credit Calculation

Activity	Acres	Crediting	Credit Acres
Restoration of historic wetland area	75	1.0 : 1	75.0
Enhancement of severely degraded areas that still meet wetland definition	17	1.0 : 1	17.0
Enhancement of marginally degraded area that still meets wetland definition	3	0.25 : 1	0.75
Adjacent upland restoration	20	0.25 : 1	5.0
Brush removal and burning in fully functioning wetland	5	0	0
Total	120		97.75

St. Paul District, 2002

TABLE 1 - RECOMMENDED COMPENSATORY MITIGATION RATIOS FOR DIRECT PERMANENT IMPACTS

Mitigation / Impacts	Restoration[1] (re-establishment)	Creation (establishment)	Enhancement (rehabilitation)	Preservation (protection/ management)
Emergent Wetlands (ac)	2:1	2:1 to 3:1	3:1 to 10:1[2]	15:1
Scrub-shrub Wetlands (ac)	2:1	2:1 to 3:1	3:1 to 10:1[2]	15:1
Forested Wetlands (ac)	2:1 to 3:1	3:1 to 4:1	5:1 to 10:1[2]	15:1
Open Water (ac)	1:1	1:1	project specific[3]	project specific
Submerged Aquatic Vegetation (ac)	5:1	project specific[4]	project specific[5]	N/A
Streams[6] (lf)	2:1[7]	N/A	3:1 to 5:1[8]	10:1 to 15:1[9]
Mudflat (ac)	2:1 to 3:1	2:1 to 3:1	project specific	project specific
Upland[10] (ac)	≥10:1[11]	N/A	project specific	15:1[12]

New England District, 2010

Decision Rules & Simple Equations

PROPOSED WETLAND MITIGATION CREDIT TABLE

Factors	Options				
Net Improvement	0.0** ------------------to ------------------ 3.0 (see Section 3.0 for examples of potential values)				
Upland Buffer	0.0 ------------------to ------------------ 1.0 (see Section 3.0 for examples of potential values)				
Credit Schedule	Not Applicable 0**	After 0.1	Concurrent 0.3	Before 0.5	
Temporal Loss	Not Applicable 0**	0 to 5 years -0.1	5 to 10 years - 0.2	10 to 20 years -0.3	Over 20 years -0.4
Kind	Out of Kind 0	In Kind 0.4			
Location	Case by Case 0	Drainage Basin 0.1	Adjacent 8-Digit HUC 0.2	8-Digit HUC 0.4	

**Use this option to calculate credit for Preservation.

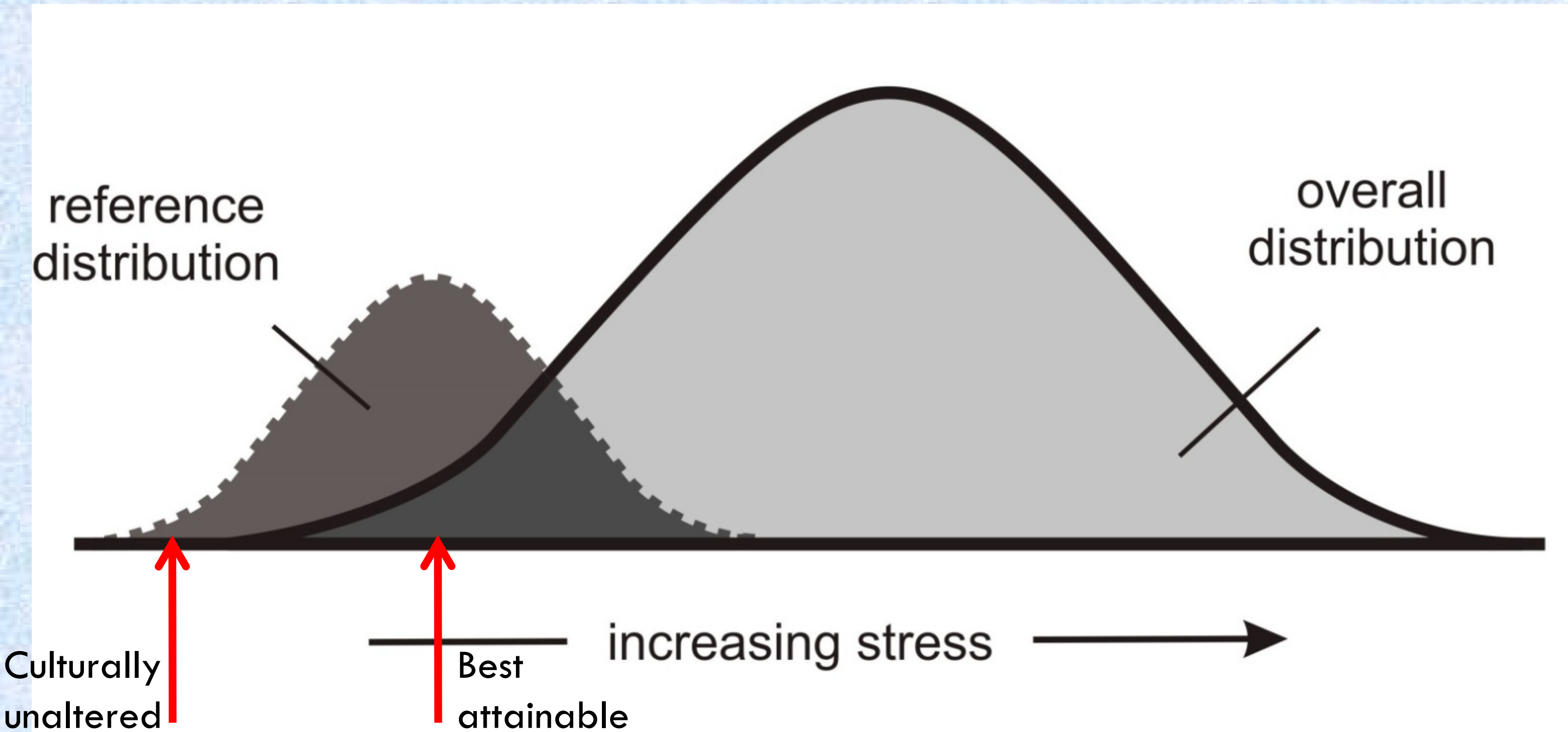
Charleston District Mitigation Guidelines, 2010

Need More Robust Crediting System

- Assesses relevant functions or services
  - Anchored to clearly defined reference conditions

All Assessment are Anchored to Reference

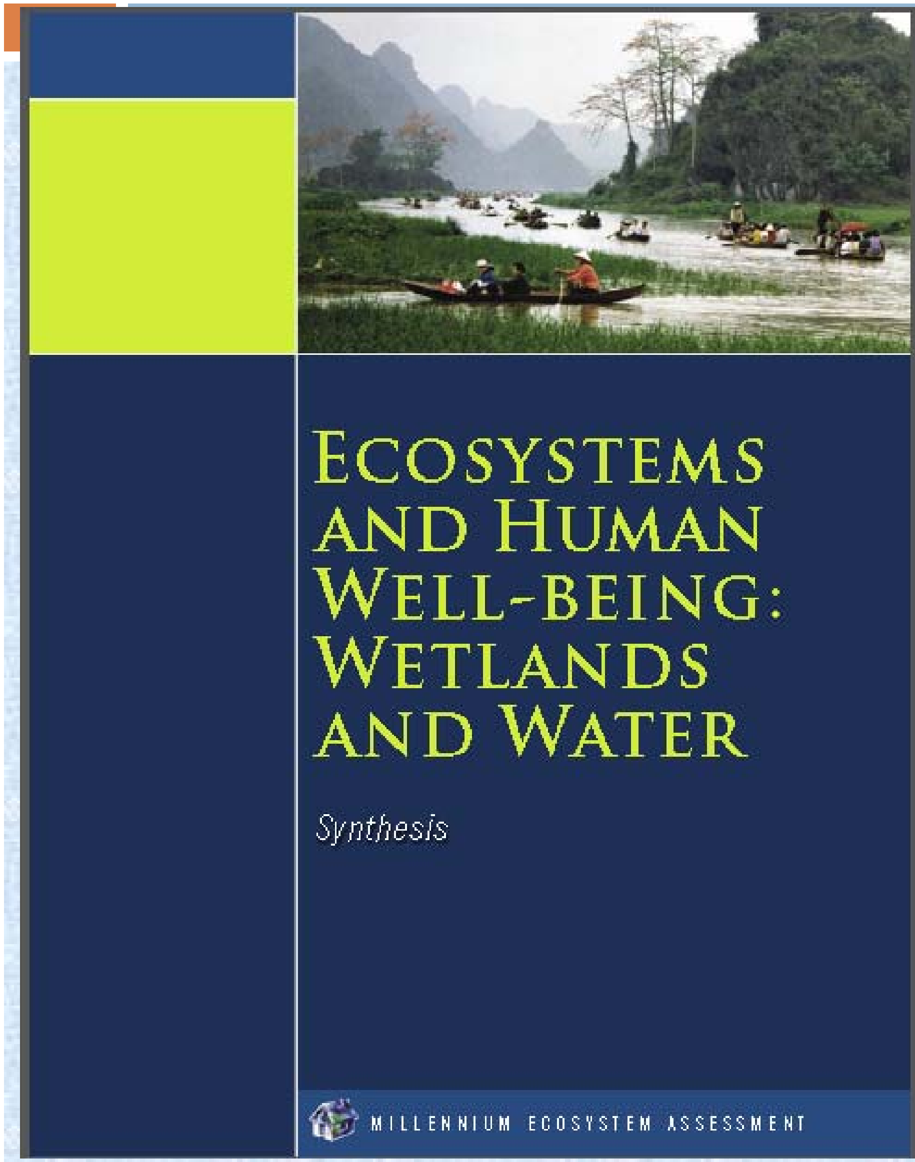
- Empirical
- Modeled
- Expert judgment

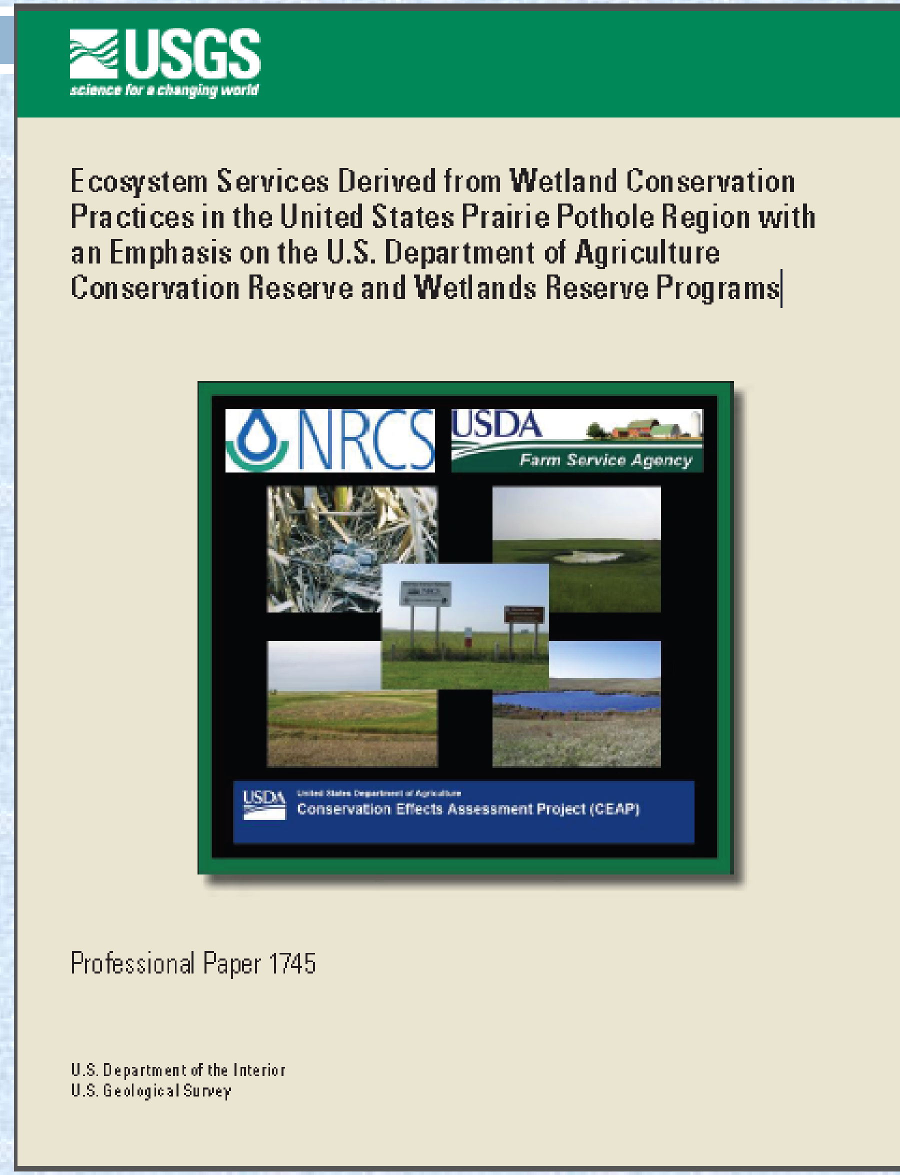


Need More Robust Crediting System

- Assesses relevant functions or services
  - Anchored to clearly defined reference conditions
- Output to appropriate unit of analysis
  - hectares, meters, conservation units
- Clear rules for combining components
  - Transparent logic
  - Averaging, summing, decision trees
- Addresses timing of compensation relative to impact
- Assesses risk factors/uncertainty

Ecosystem Service Assessments

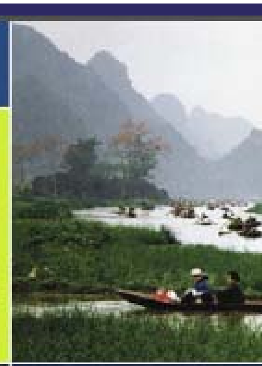




Ecosystem Service Assessments

Table 1. Ecosystem S

Services
Provisioning
Food
Fresh water[a]
Fiber and fuel
Biochemical
Genetic materials
Regulating
Climate regulation
Water regulation (hydrolo
Water purification and wa
Erosion regulation
Natural hazard regulation
Pollination
Cultural
Spiritual and inspirational
Recreational
Aesthetic
Educational
Supporting
Soil formation
Nutrient cycling



ECOSYS
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Synthesis

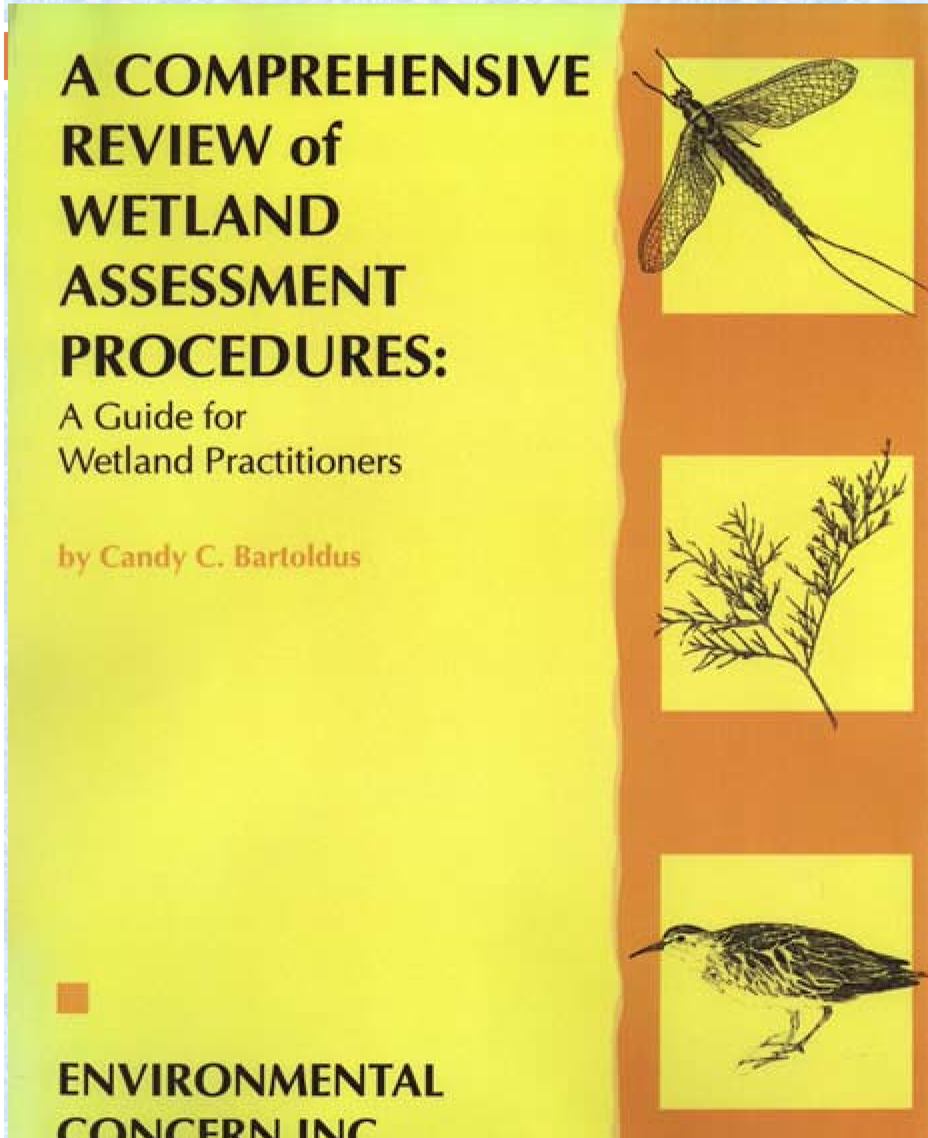
MILLENNIUM ECOSYSTEM ASSESSMENT

Table 1: Target Currencies and Foundational

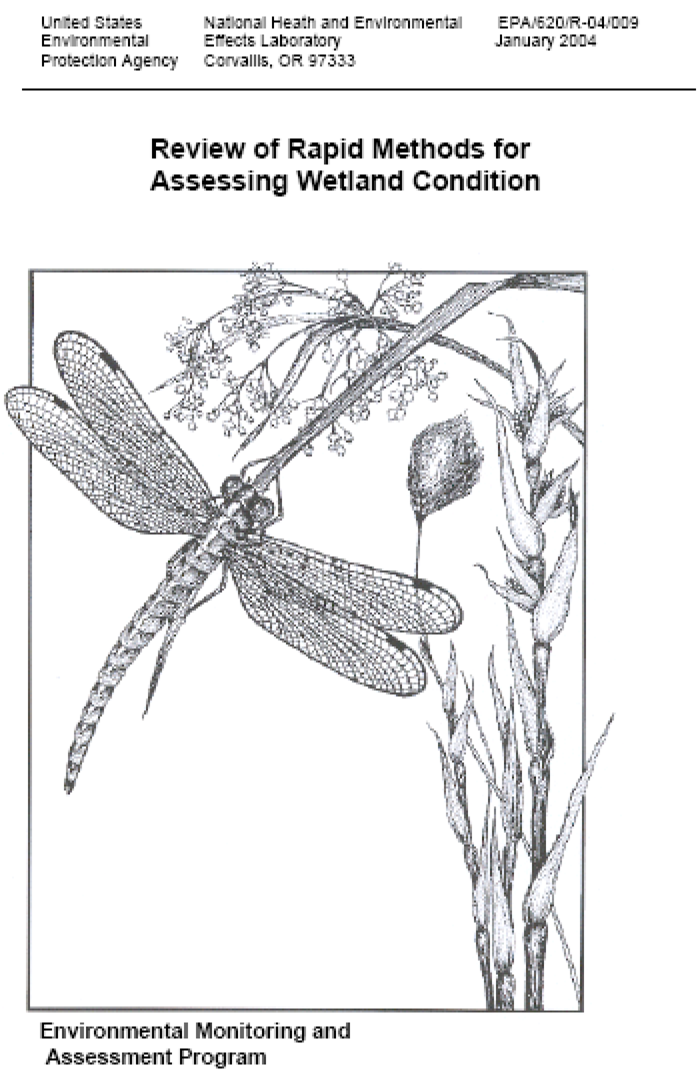
Version 1. Target Currency	Tradable Unit
Water Quality- Temperature	Kcal/day
Wetland habitat	Acres & Services
Salmonid habitat	Weighted linear feet
Prairie habitat	Functionally weighted acre
Water Quality- Nitrogen & Phosphorous*	Lbs/year
Near-term Priority Currency	**Tradable Unit**
Carbon	Mt tonne
Streams	Weighted linear foot
Water Quality- sediment retention	Lbs/year
Medium-term Priority Currency	**Tradable Unit**
Water quality- flow regime	Cubic foot/sec
Oak woodland	Functionally weighted acre

Willamette Partnership , 2008

Condition or Function Assessment



http://www.wetland.org/publications_home.htm



Typical Classes of Indicators

- Habitat structure, diversity, complexity
  - Response guilds
- Hydrology or geomorphology
- Biogeochemistry
- Landscape context
  - Connectivity
  - Buffers

Evaluate ecological processes (function) or bundles of processes (condition)

Hydrogeomorphic (HGM) Method

Table 4.2 Relati … iver System

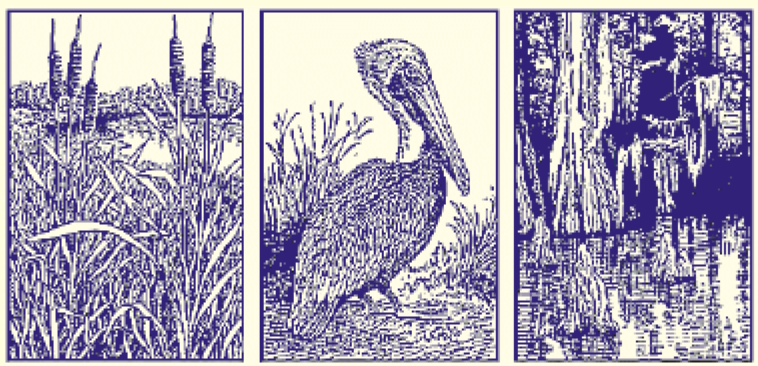
Functions / Variables	Surfac… Gro… Wa… Storag… Fl…	…eristic …tic …brate …ats	Characteristic Vertebrate Habitats
$V_{BUFFCON}$			X
$V_{COMPLEX}$			X
V_{CWD}			
V_{FPCON}			X
V_{GEOMOD}	X		
$V_{HYDROMOD}$	X		
$V_{LONGPROF}$	X		
V_{MACRO}	X		X
V_{NPHERB}			X
$V_{NPSHRUB}$			X
V_{NPTREE}			X
$V_{ORGDECOMP}$			
V_{PERM}	X		
$V_{SEDSOURCE}$			
V_{SHGW}	X		
$V_{SURFREQ}$	X		X

US Army Corps of Engineers
Waterways Experiment Station

Wetlands Research Program Technical Report WRP-DE-9

An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices

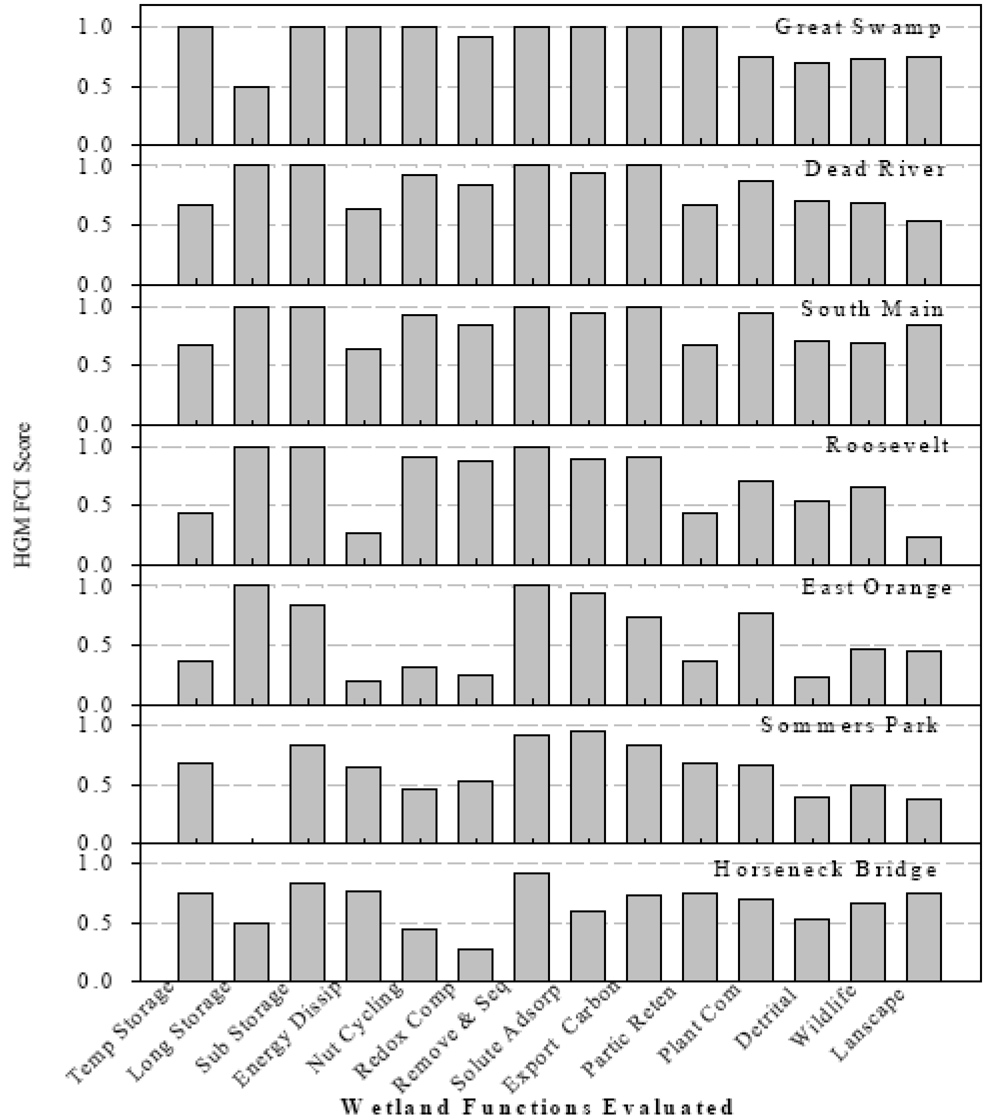
by R. Daniel Smith, Alan Ammann, Candy Bartoldus, and Mark M. Brinson



October 1995 – Final Report
Approved For Public Release; Distribution Is Unlimited

Assessment Output

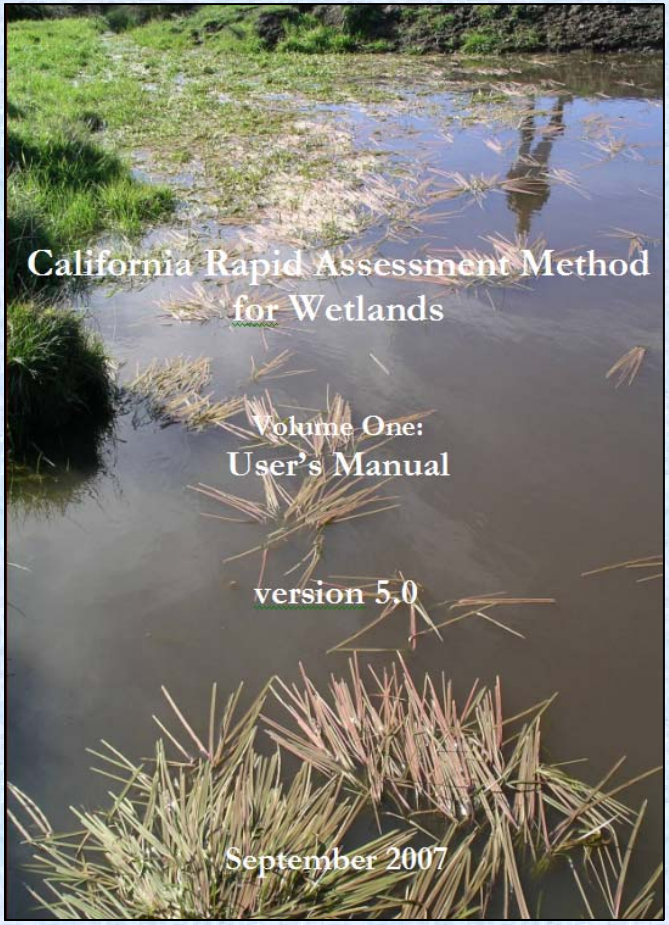
Figure 5. HGM scores that rate functional capacity indices (FCIs) for the seven wetlands.



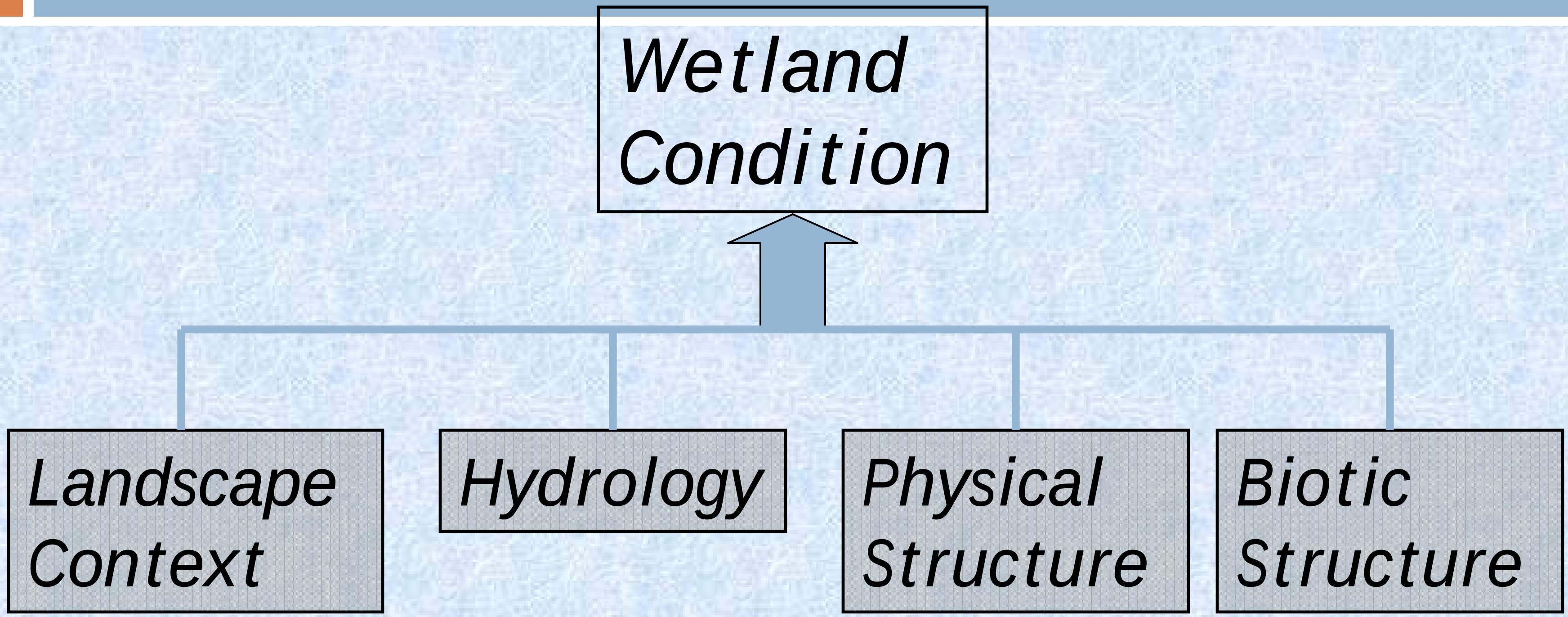
Condition Assessments

California Rapid Assessment CRAM

- Field-based, rapid tool to assess wetland condition
- Applicable to all wetland types
- Based on readily observable field indicators → simple numerical output
- Evaluates broad suite of wetland conditions (i.e. bundles of functions)
- Validated with more intensive measures of condition

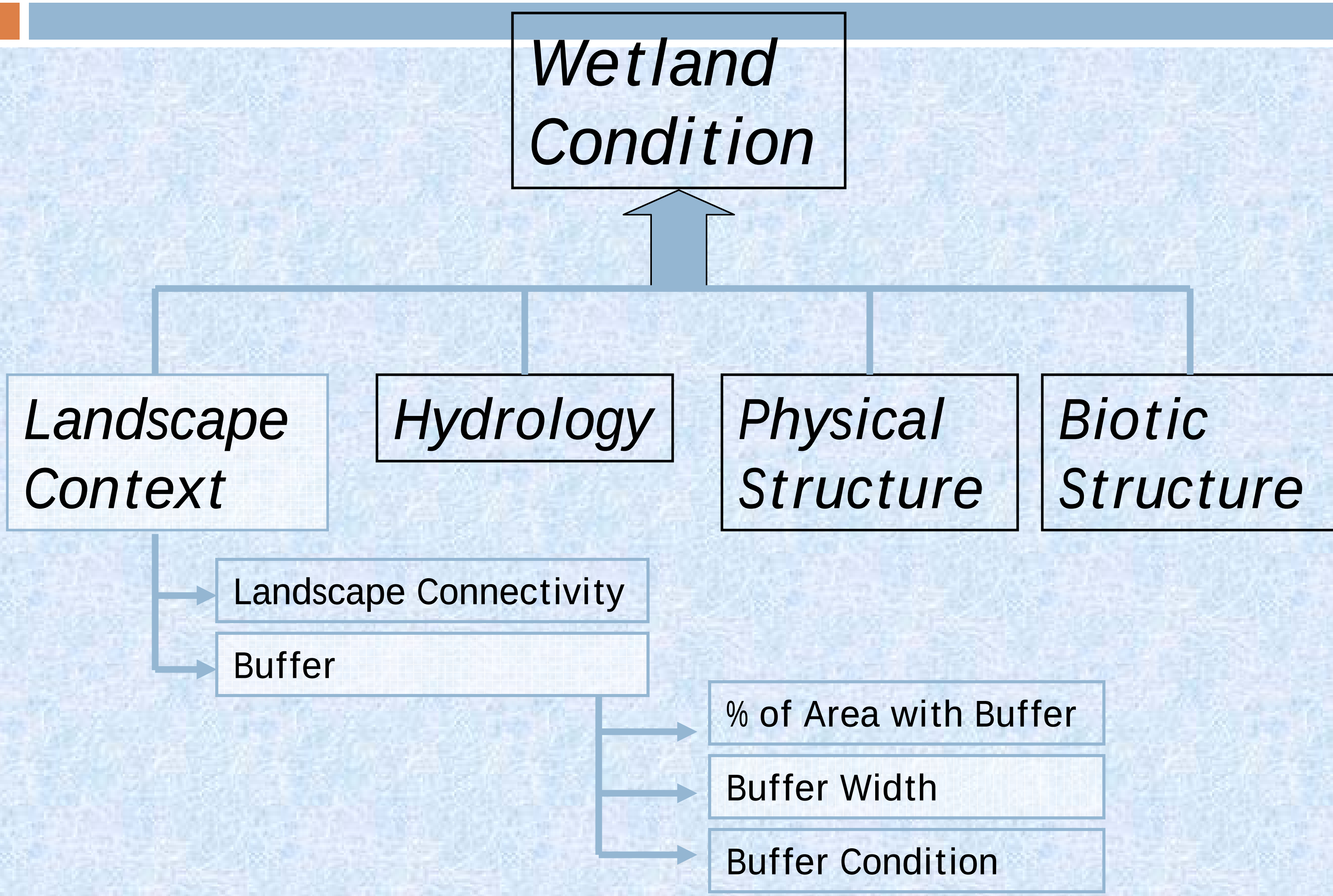


CRAM Design: Attributes

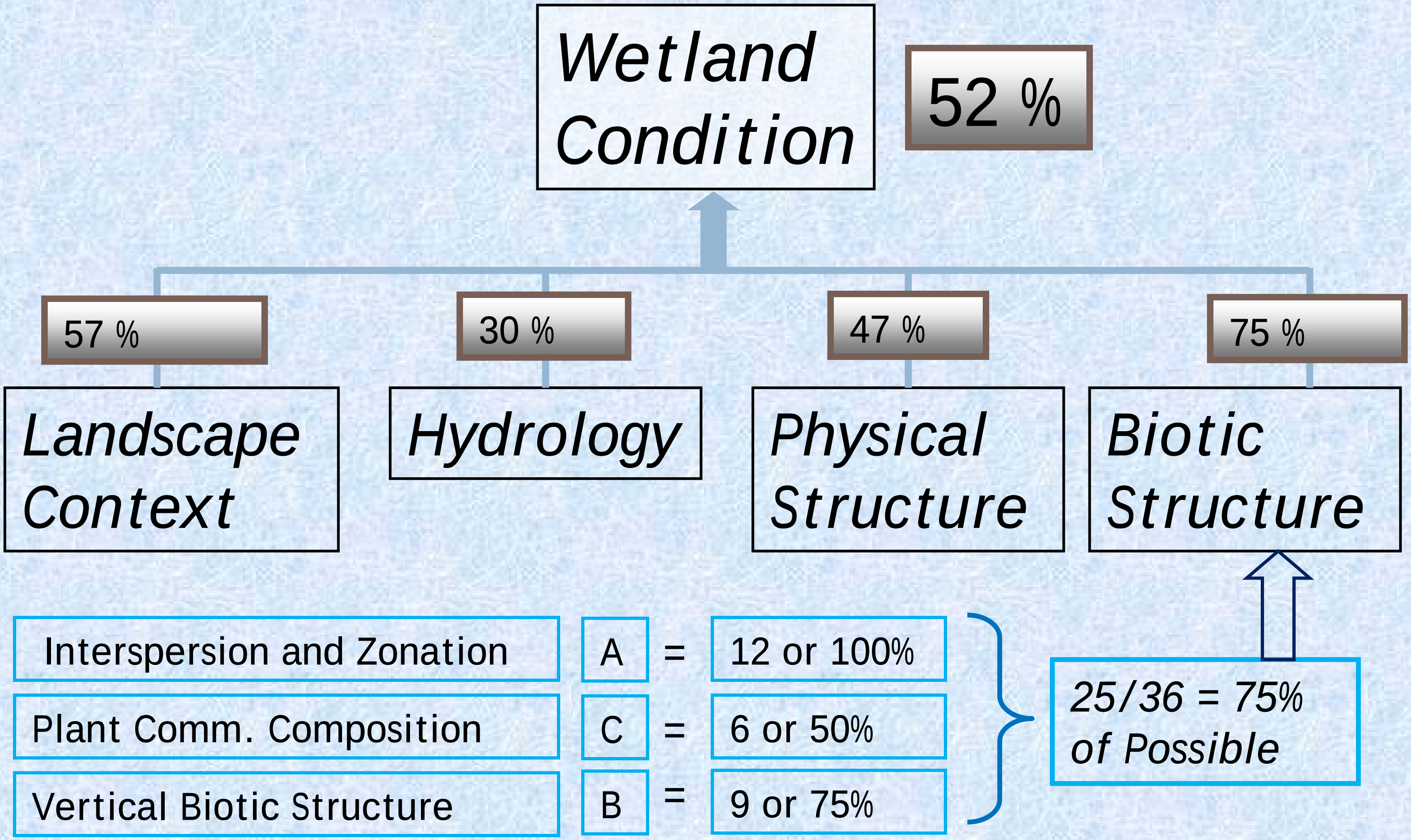


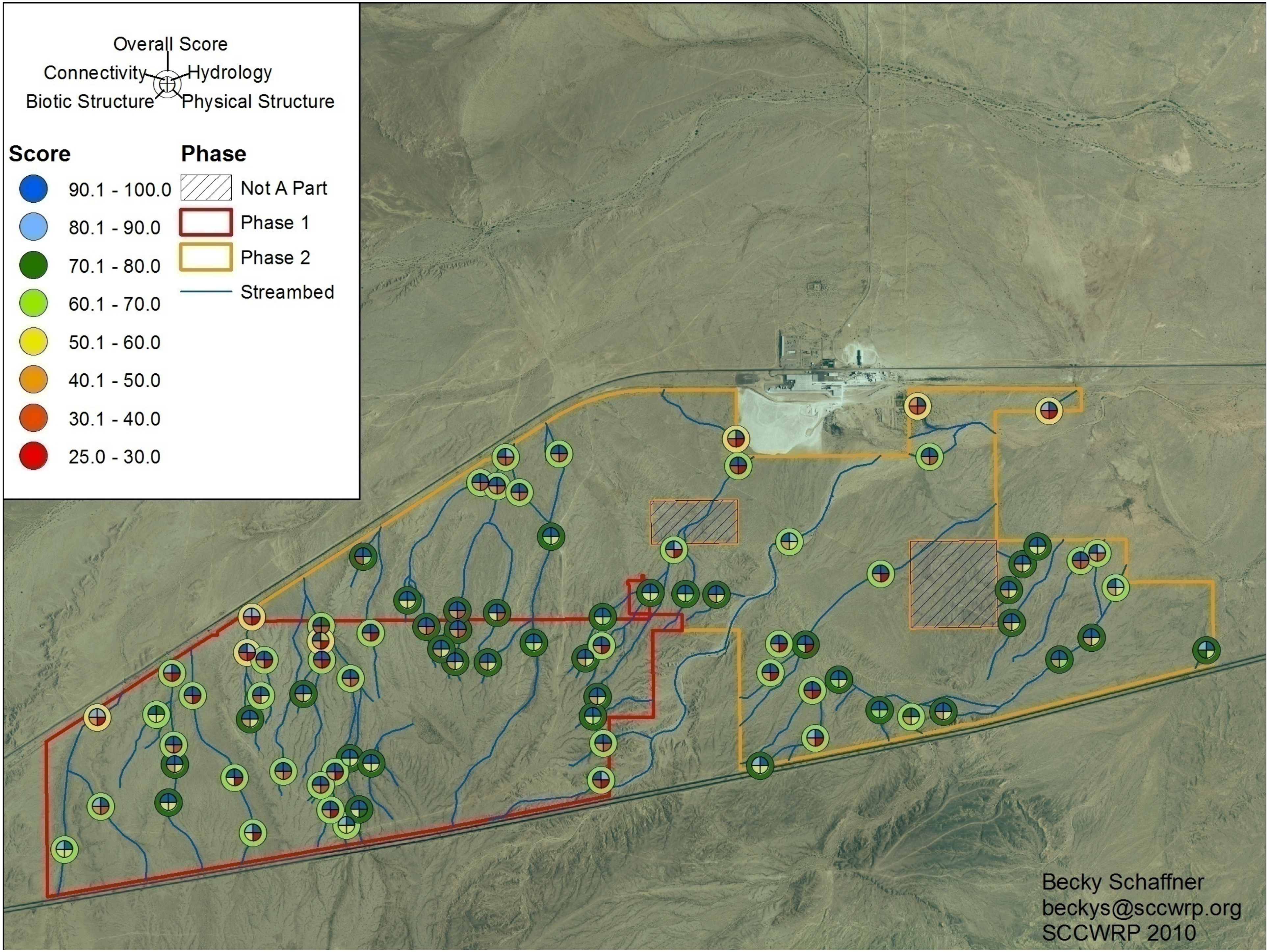
- CRAM recognizes four attributes of wetland condition
- Each attribute is represented by 2-3 metrics, some of which have sub-metrics.

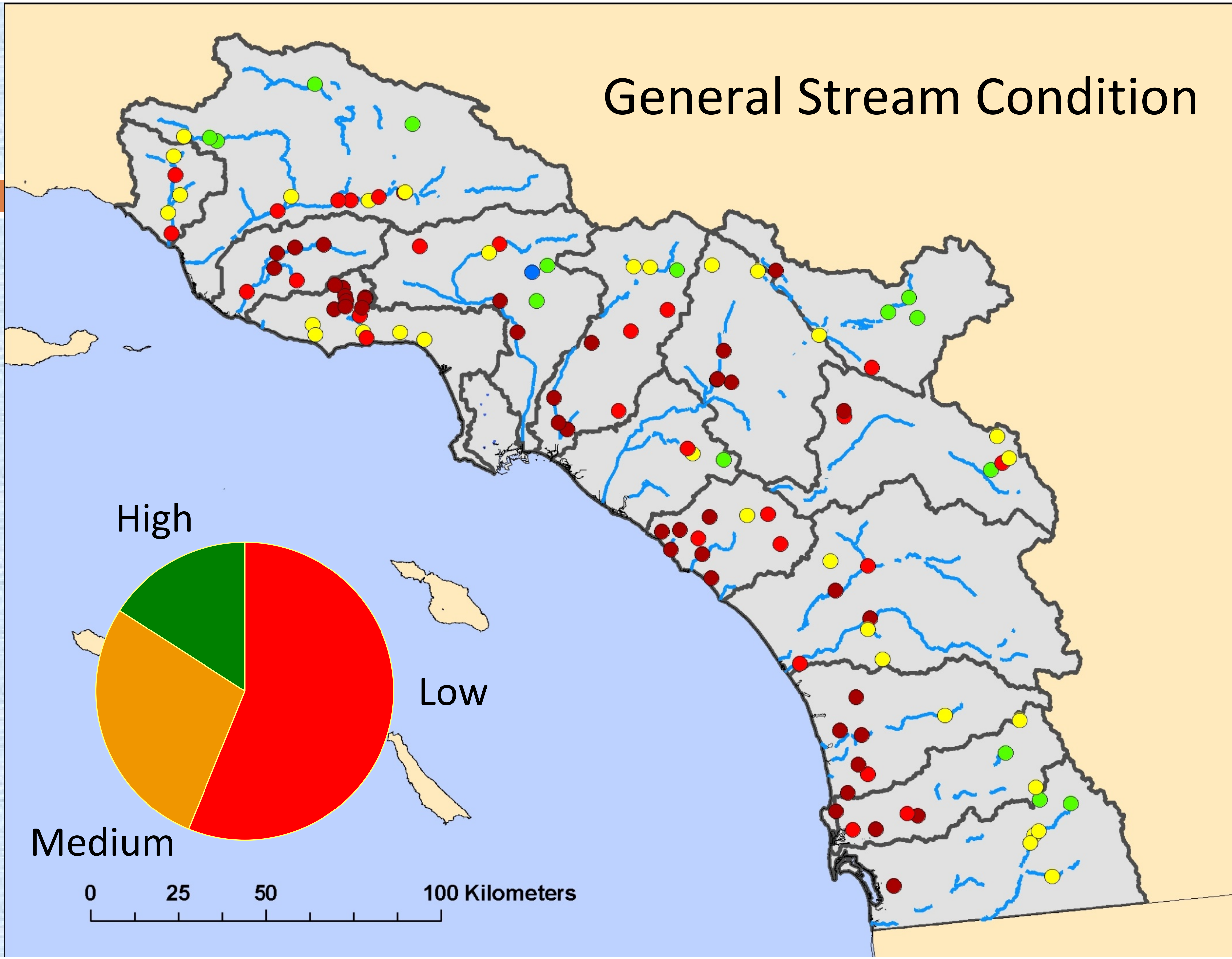
CRAM Design: Metrics



CRAM Scoring




Overall Score
Connectivity
Hydrology
Biotic Structure
Physical Structure
Score
90.1 - 100.0
80.1 - 90.0
70.1 - 80.0
60.1 - 70.0
50.1 - 60.0
40.1 - 50.0
30.1 - 40.0
25.0 - 30.0
Phase
Not A Part
Phase 1
Phase 2
Streambed
Becky Schaffner
beckys@sccwrp.org
SCCWRP 2010


General Stream Condition
High
Low
Medium
0
25
50
100 Kilometers

Mitigation Assessment Based on CRAM

AA	Buffer and Lanscape Context			Hydrology			Physical Structure			Biotic Structure		
	pre	post	change	pre	post	change	pre	post	change	pre	post	change
A1	85	100	15	100	100	0	50	88	38	64	100	36
A2	85	100	15	100	100	0	50	75	25	39	100	61
B1	85	0	(85)	100	0	(100)	63	0	(63)	31	0	(31)
B2	85	0	(85)	100	0	(100)	50	0	(50)	50	0	(50)
B3	85	0	(85)	92	0	(92)	63	0	(63)	44	0	(44)
B4	85	0	(85)	100	0	(100)	75	0	(75)	64	0	(64)
B5	85	0	(85)	100	0	(100)	75	0	(75)	60	0	(60)
H2	0	59	59	0	92	92	0	63	63	0	100	100
H3	0	52	52	0	92	92	0	75	75	0	100	100
H4	83	97	14	100	83	(17)	63	88	25	53	100	47
H5	85	93	8	100	92	(8)	63	88	25	61	100	39

Setting Mitigation Ratios

Los Angeles District, Corps

Before-After-Mitigation-Impact (BAMI) procedure (CRAM example)

Functions/conditions	$Impact_{Before}$	$Impact_{After}$	$Impact_{delta}$	$Mitigation_{Before}$	$Mitigation_{After}$	$Mitigation_{delta}$
4.1 Buffer and Landscape Context						
4.1.1 Landscape Connectivity	9	3	-6	6	6	0
4.1.2 Percent of AA with Buffer	12	6	-6	3	9	6
4.1.3 Average Buffer Width	3	3	0	3	12	9
4.1.4 Buffer Condition	6	6	0	3	9	6
RAW SCORE	**15.0**	**8.0**	**-7**	**9.0**	**15.7**	**7**
FINAL SCORE	**62.5**	**33.6**	**-29**	**37.5**	**65.3**	**28**
4.2 Attribute 2: Hydrology						
4.2.1 Water Source	6	6	0	6	6	0
4.2.2 Hydroperiod or Channel Stability	9	12	3	3	9	6
4.2.3 Hydrologic Connectivity	12	9	-3	3	12	9
RAW SCORE	**27.0**	**27.0**	**0**	**12.0**	**27.0**	**15**
FINAL SCORE	**75.0**	**75.0**	**0**	**33.4**	**75.0**	**42**
4.3 Attribute 3: Physical Structure						
4.3.1 Structural Patch Richness	6	3	-3	3	9	6
4.3.2 Topographic Complexity	6	3	-3	3	6	3
RAW SCORE	**12.0**	**6.0**	**-6**	**6.0**	**15.0**	**9**
FINAL SCORE	**50.0**	**25.0**	**-25**	**25.0**	**62.5**	**38**
4.4 Attribute 4: Biotic Structure						
4.4.1 Number of Plant Layers	12	9	-3	6	9	3
4.4.2 Co-Dominant Species	6	6	0	6	12	6
4.4.3 Percent Invasion	6	9	3	3	12	9
4.4.5 Interspersion/Zonation	9	3	-6	3	9	6
4.4.6 Vertical Structure	6	3	-3	3	6	3
RAW SCORE	**23**	**14**	**-9**	**11**	**26**	**15**
FINAL SCORE	**63.9**	**38.9**	**-25**	**30.6**	**72.3**	**42**
OVERALL SCORE	**65.0**	**46.0**	**-19**	**32.0**	**70.0**	**38**

Restoration Monitoring

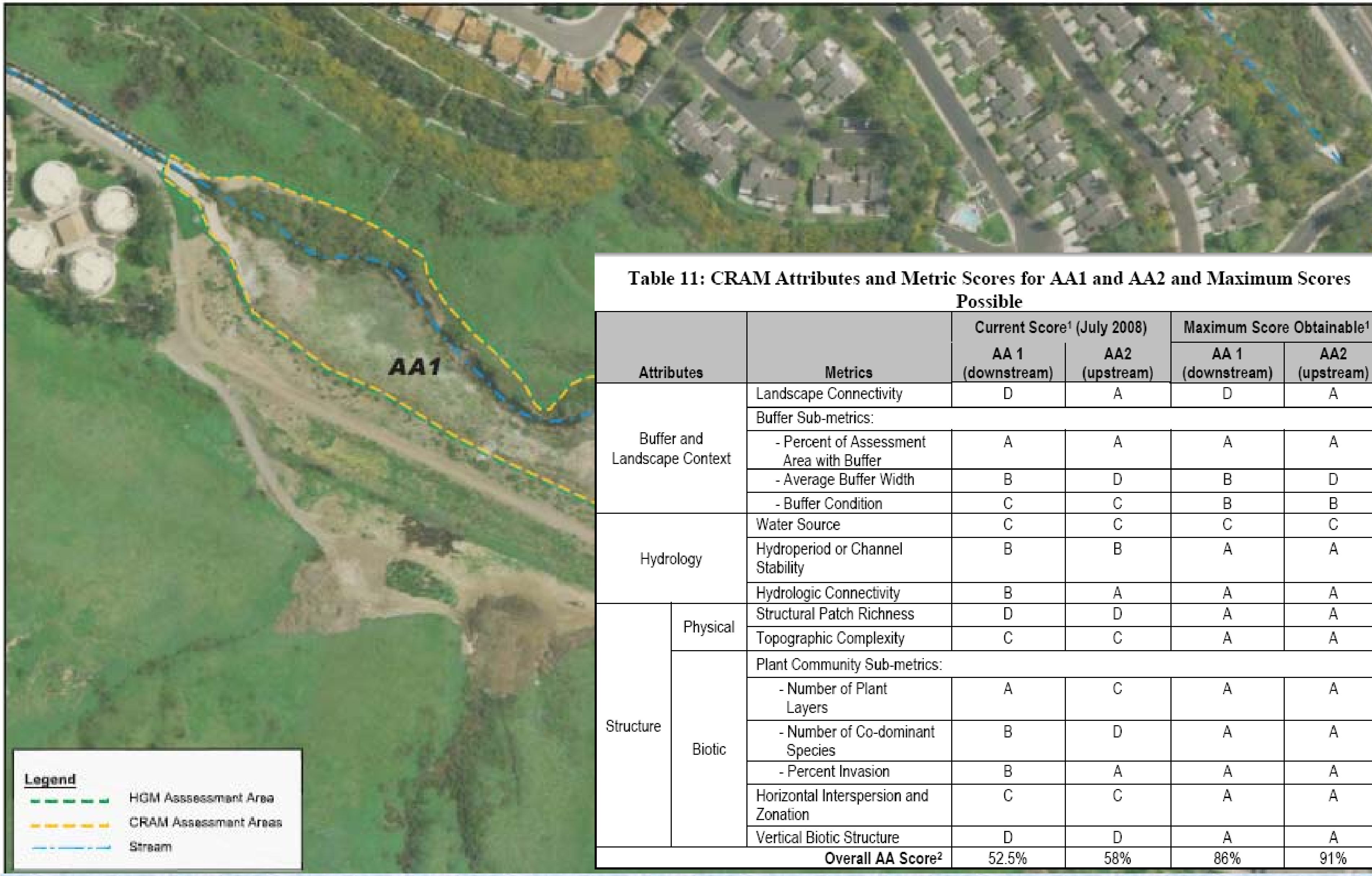
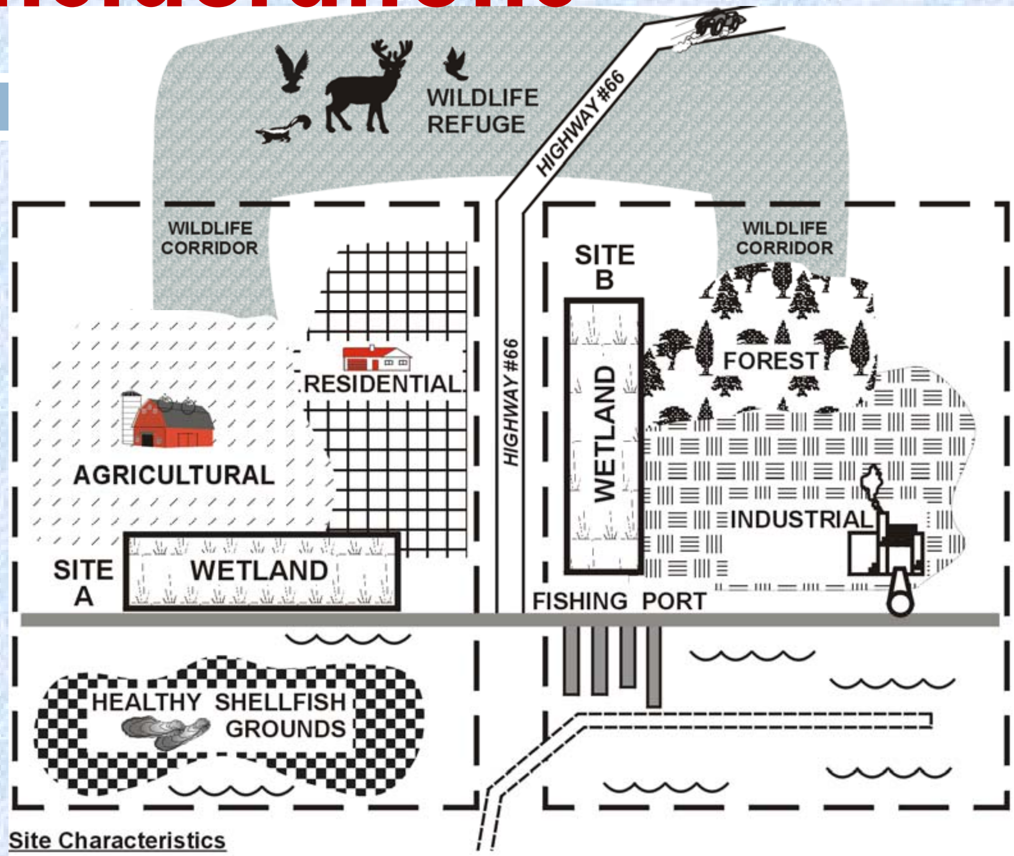


Table 11: CRAM Attributes and Metric Scores for AA1 and AA2 and Maximum Scores Possible

Attributes		Metrics	Current Score[1] (July 2008)		Maximum Score Obtainable[1]	
			AA 1 (downstream)	AA2 (upstream)	AA 1 (downstream)	AA2 (upstream)
Buffer and Landscape Context		Landscape Connectivity	D	A	D	A
		Buffer Sub-metrics:				
		- Percent of Assessment Area with Buffer	A	A	A	A
		- Average Buffer Width	B	D	B	D
		- Buffer Condition	C	C	B	B
Hydrology		Water Source	C	C	C	C
		Hydroperiod or Channel Stability	B	B	A	A
		Hydrologic Connectivity	B	A	A	A
Structure	Physical	Structural Patch Richness	D	D	A	A
		Topographic Complexity	C	C	A	A
	Biotic	Plant Community Sub-metrics:				
		- Number of Plant Layers	A	C	A	A
		- Number of Co-dominant Species	B	D	A	A
		- Percent Invasion	B	A	A	A
		Horizontal Interspersion and Zonation	C	C	A	A
		Vertical Biotic Structure	D	D	A	A
		Overall AA Score[2]	52.5%	58%	86%	91%

Additional Considerations

- Mitigation site location
- Type of mitigation
- Cumulative effects
- Type conversion
- Uncertainty
- Temporal loss



Site Characteristics

Wetland Site A and Wetland Site B are identical in size, shape and bio-physical characteristics and are located in the same sub-watershed on either side of Highway 66.

Landscape Context

SITE A
- near the coast, downstream is a beach area
- adjacent to large healthy shellfish grounds that are accessible to the community
- upslope is agricultural land (nutrient run off)
- wildlife corridor open from the North
- near residential areas (aesthetics, scenic)
- good access, adjacent public lands
- access to many urban poor people

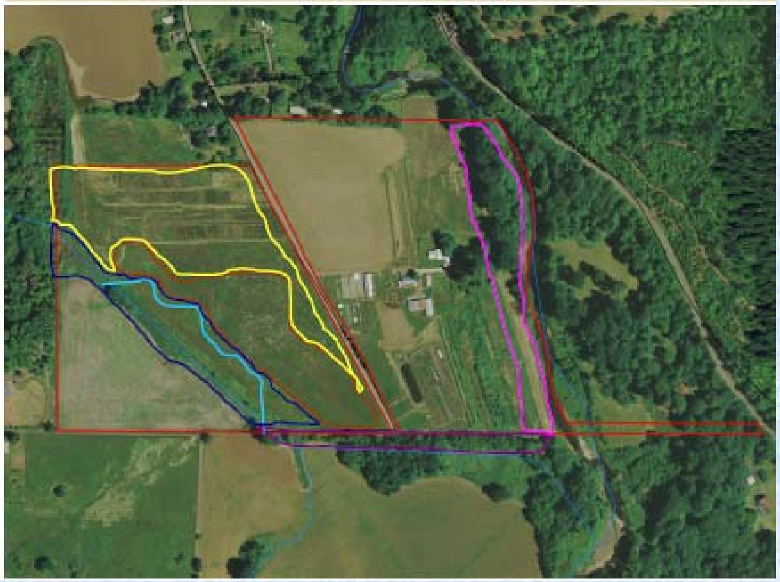
SITE B
- slightly off coast, downstream is industrial site
- adjacent to fishing port and small shellfish beds that are contaminated and remote
- upslope is forest (no nutrient runoff)
- wildlife corridor is blocked by Highway 66
- nearby industrial sites (no proximity to people)
- poor access, surrounded by private lands
- access to few suburban rich people

King and Price 2006

Type of Mitigation

- Creation
- Type conversion
- Restoration
- Enhancement
- Preservation

Increasing mitigation ratios

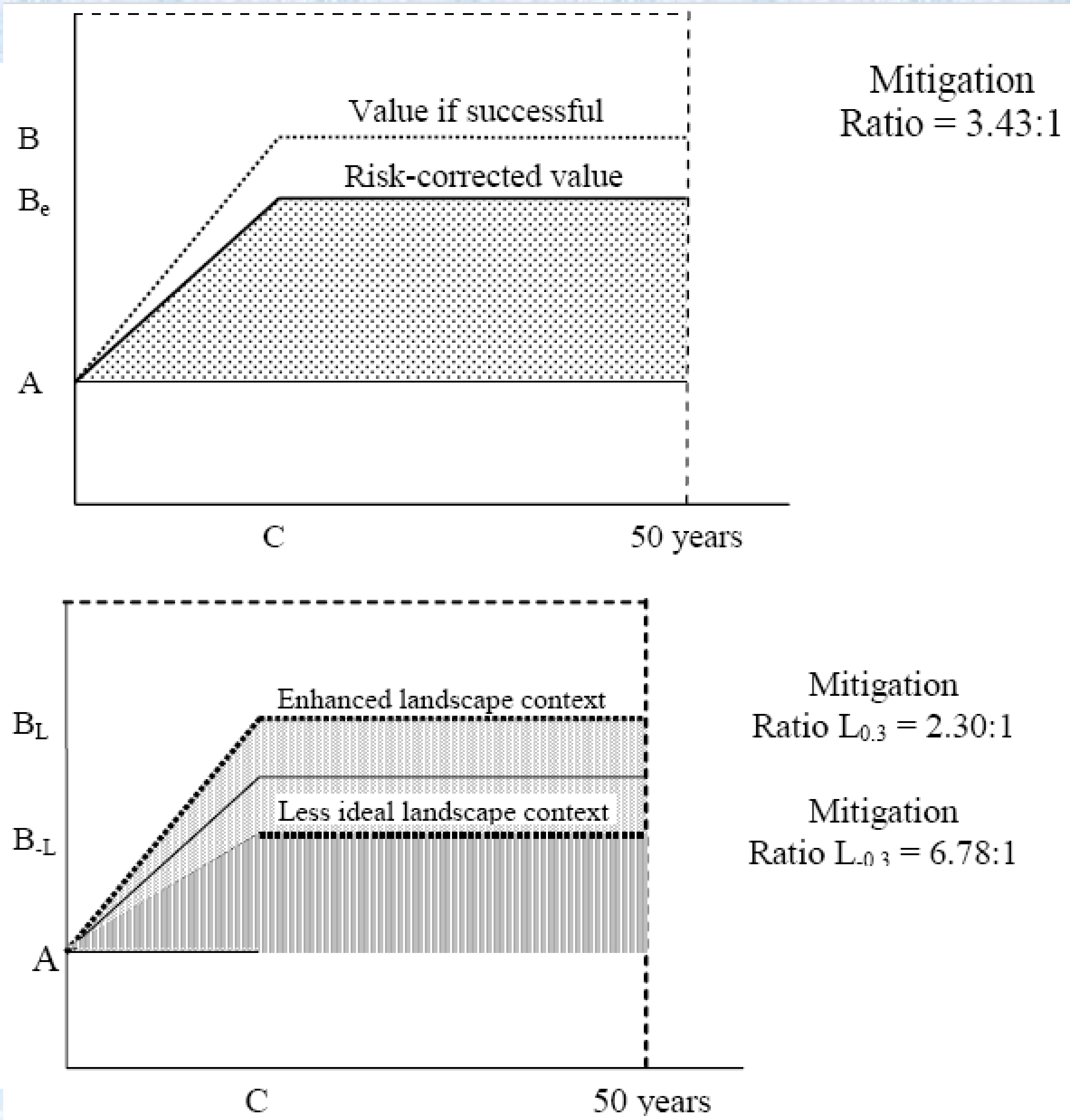


Considerations for Preservation

the district engineer should apply a higher mitigation ratio if the requirements are to be met through the use of preservation credits.

- Ecological value
- Position relative to other resources of concern
- Threat/risk

Adjusting Mitigation Ratios Based on Risk



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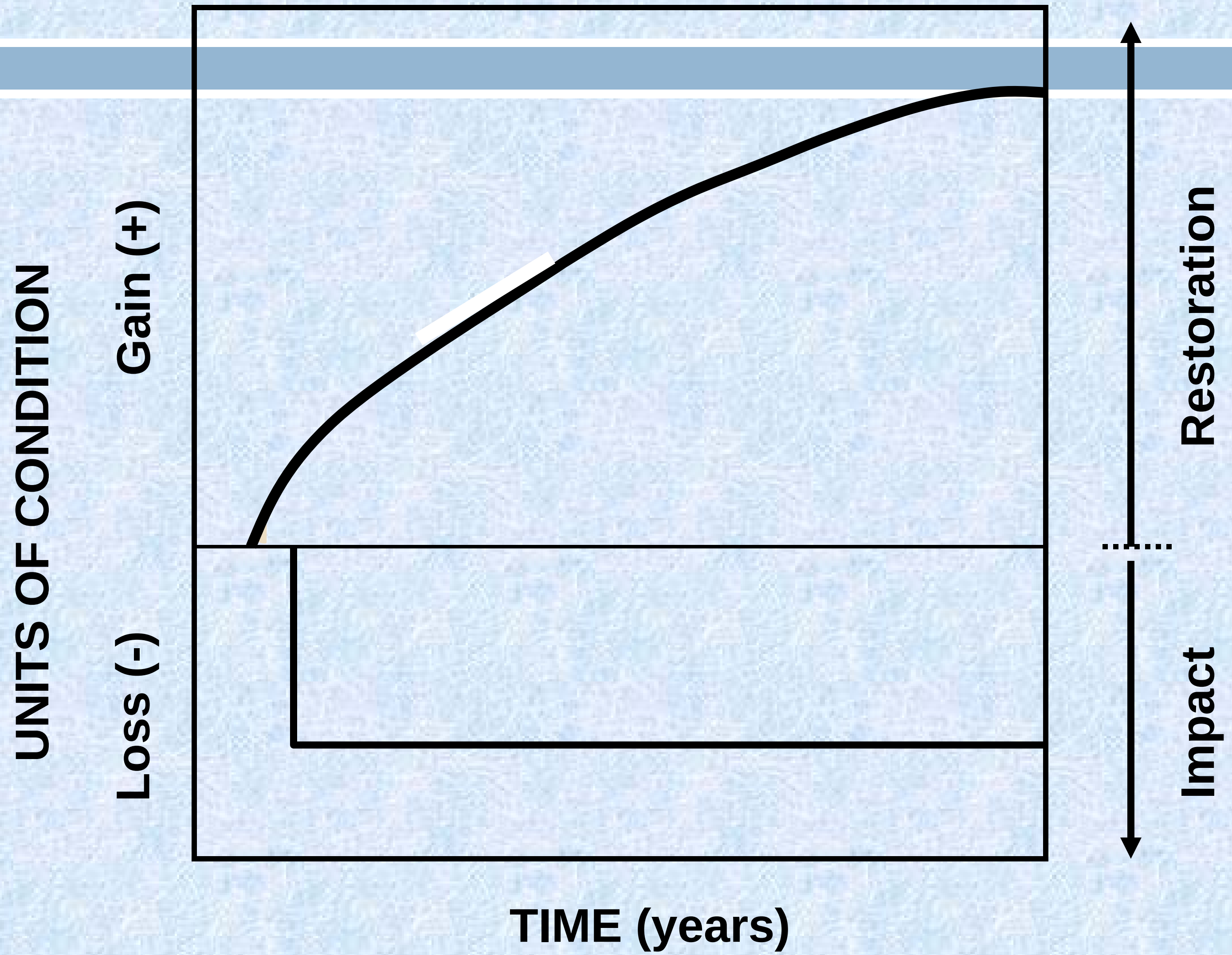
King and Price 2004

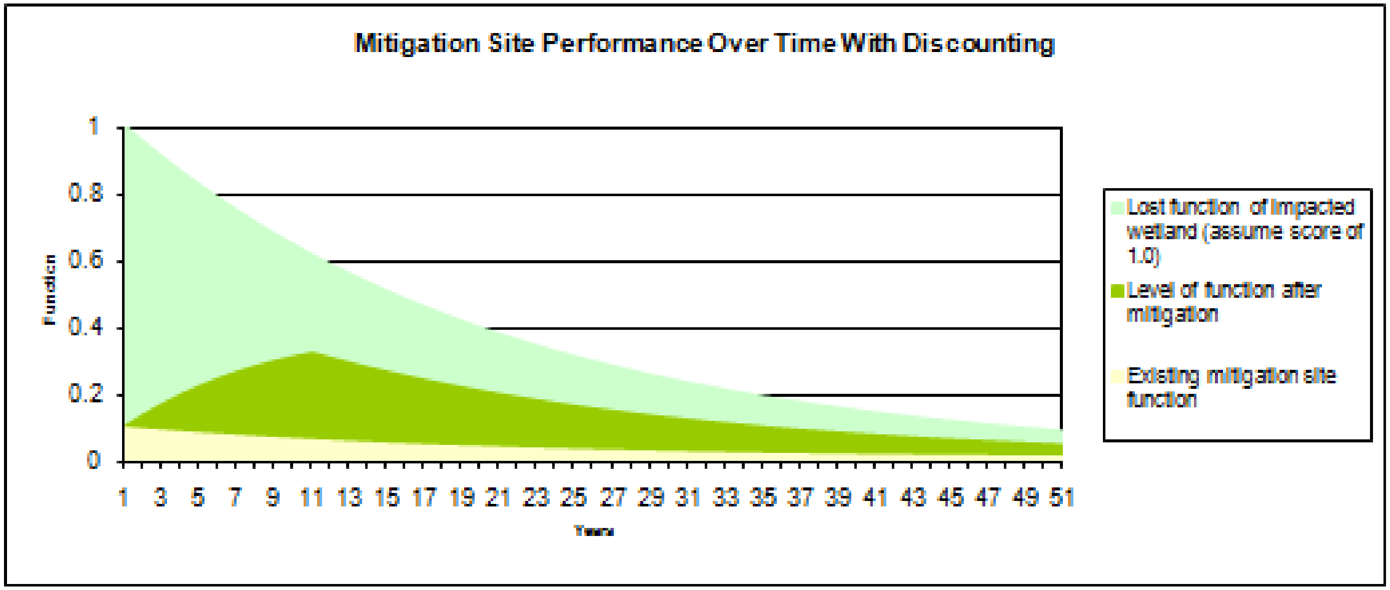
Adjusting Mitigation Ratios

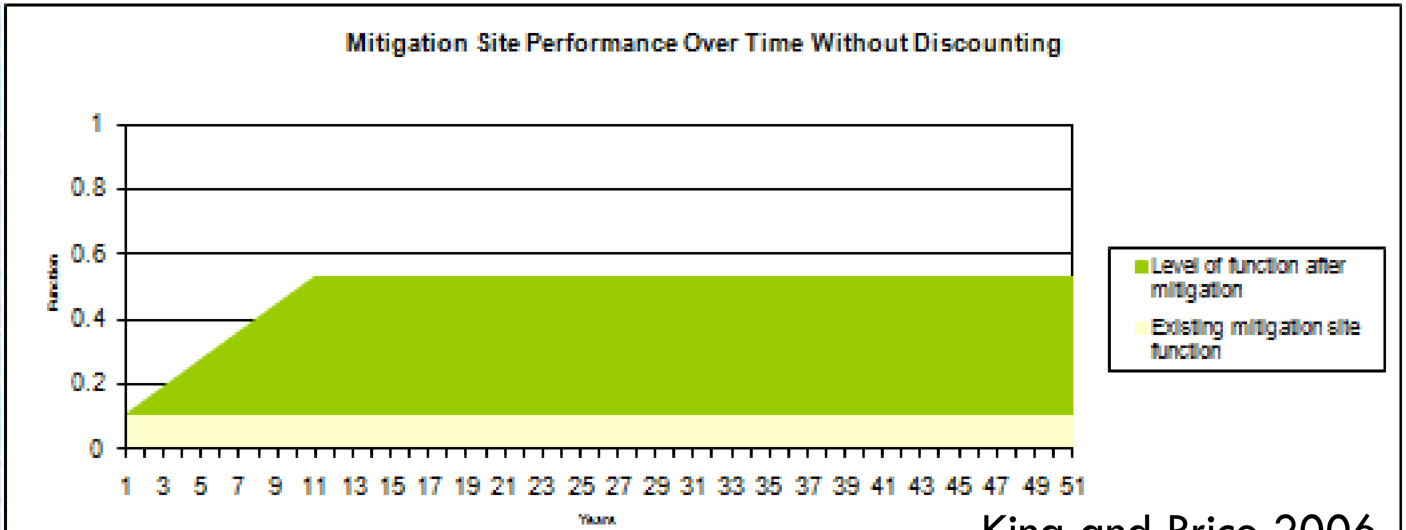
	Parameters					
	A	B	C	D	E	L
Concurrent Creation	0	0.7	10	0	0	0
Advanced Creation	0	0.7	10	5	0	0
Delayed Creation	0	0.7	10	-5	0	0
Concurrent Restoration	0.1	0.7	10	0	0	0
Original Wetland Degraded	0	1.4	10	0	0	0
Concurrent Enhancement	0.4	0.7	10	0	0.2	0
Concurrent, Enhanced Landscape	0	0.7	10	0	0	0.3
Concurrent, Less ideal Landscape	0	0.7	10	0	0	-0.3
Difficult Creation	0	0.7	10	0	0.5	0
Very Difficult Creation	0	0.7	10	0	0.75	0
Same, Advanced & Risk Adjusted	0	0.7	10	5	0.2	0

Temporal Losses



Discounting (*change over time*)





King and Price 2006

Mitigation Ratio Calculation for Temporal Loss

NOTE: this calculation is only for temporal loss. Initial mitigation ratio can be calculated from the equation:
Initial Mitigation Ratio = Impact site loss / Mitigation site gain
Impact site loss = impact site condition * unit loss (acres or feet)
Mitigation site gain = mitigation site condition * unit gain (acres or feet)

Parameters	
Time horizon (generally 50 years)	50
Intial aquatic resource condition (0 - 1.0)	0.1
Final aquatic resource condition (0 - 1.0)	0.75
Years needed to reach full functionality (years)	10
Years of delays	0
Likelihood of failing	0
Landscape effects (-0.2 = 20% decrease due to landscape)	-0.3
Discount rate for comparing values at different times	0.05

Likelihood of failure
Please enter a number between 0 (0% chance of failure) and 1.0 (100% chance of failure).

Final Mitigation Ratio	3.1

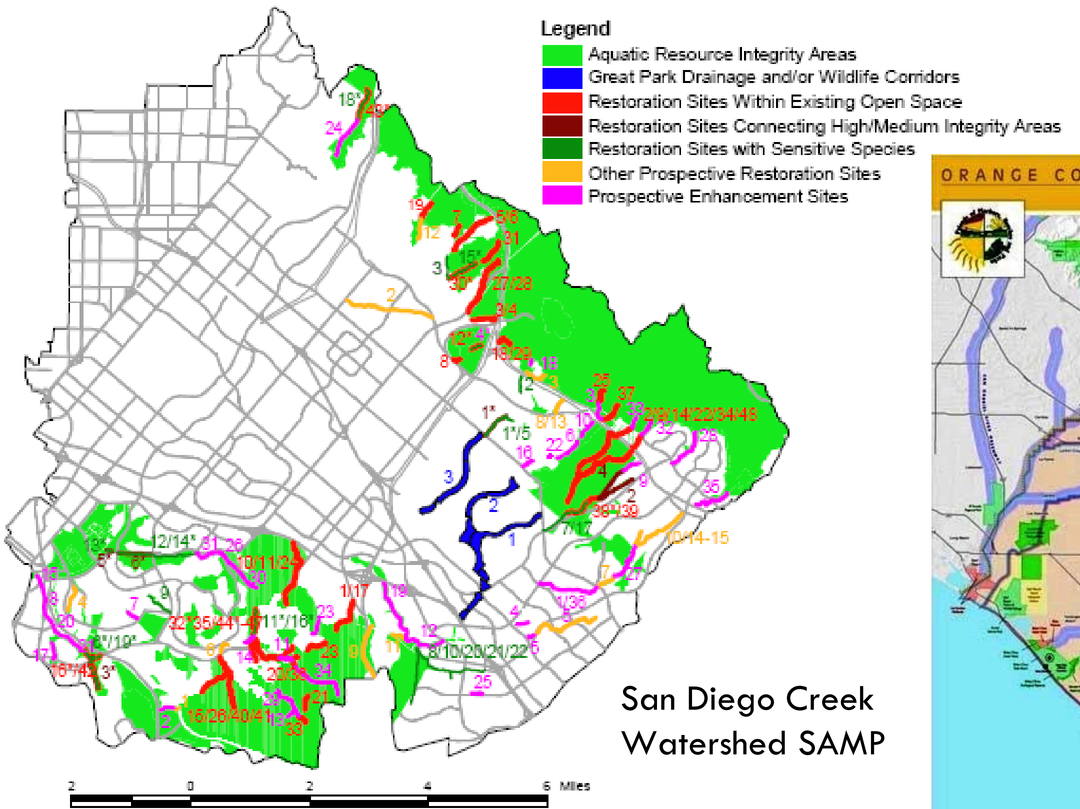
Table 1. Calculated compensation ratios for a variety of hypothetical compensation scenarios, based on a time horizon (T_{max}) of 50 years.

	Parameters						COMPENSATION RATIOS Discount Rate		
	A	B	C	D	E	L	0%	5%	10%
Concurrent Creation	0	0.7	10	0	0	0	1.6	1.9	2.3
Advanced Creation	0	0.7	10	5	0	0	1.4	1.5	1.4
Delayed Creation	0	0.7	10	-5	0	0	1.8	2.5	3.8
Concurrent Restoration	0.1	0.7	10	0	0	0	1.9	2.2	2.7
Original Wetland Degraded	0	1.4	10	0	0	0	0.8	1.0	1.2
Concurrent Enhancement	0.4	0.7	10	0	0.2	0	7.0	8.3	10.2
Concurrent, Enhanced Landscape	0	0.7	10	0	0	0.3	1.2	1.5	1.8
Concurrent, Less ideal Landscape	0	0.7	10	0	0	-0.3	2.3	2.7	3.3
Difficult Creation	0	0.7	10	0	0.5	0	3.2	3.8	4.7
Very Difficult Creation	0	0.7	10	0	0.75	0	6.4	7.6	9.4
Same, Advanced & Risk Adjusted	0	0.7	10	5	0.2	0	1.8	1.8	1.8

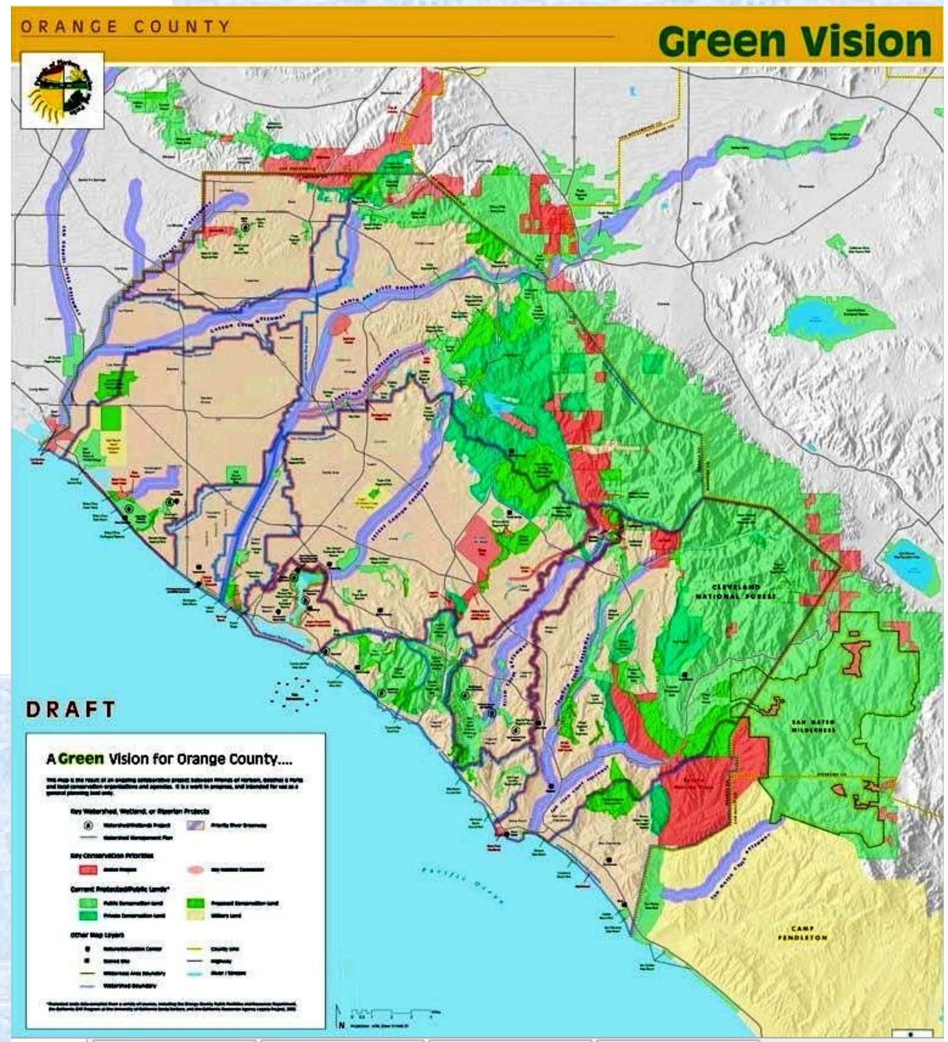
Ways to Reduce Risk/Uncertainty

- Up-front mitigation
- Watershed-based decision making
- Coordination with existing preserves
  - Adjacent
  - Additional work within preserved lands
  - Cooperation on long-term management

Watershed-based Decisions



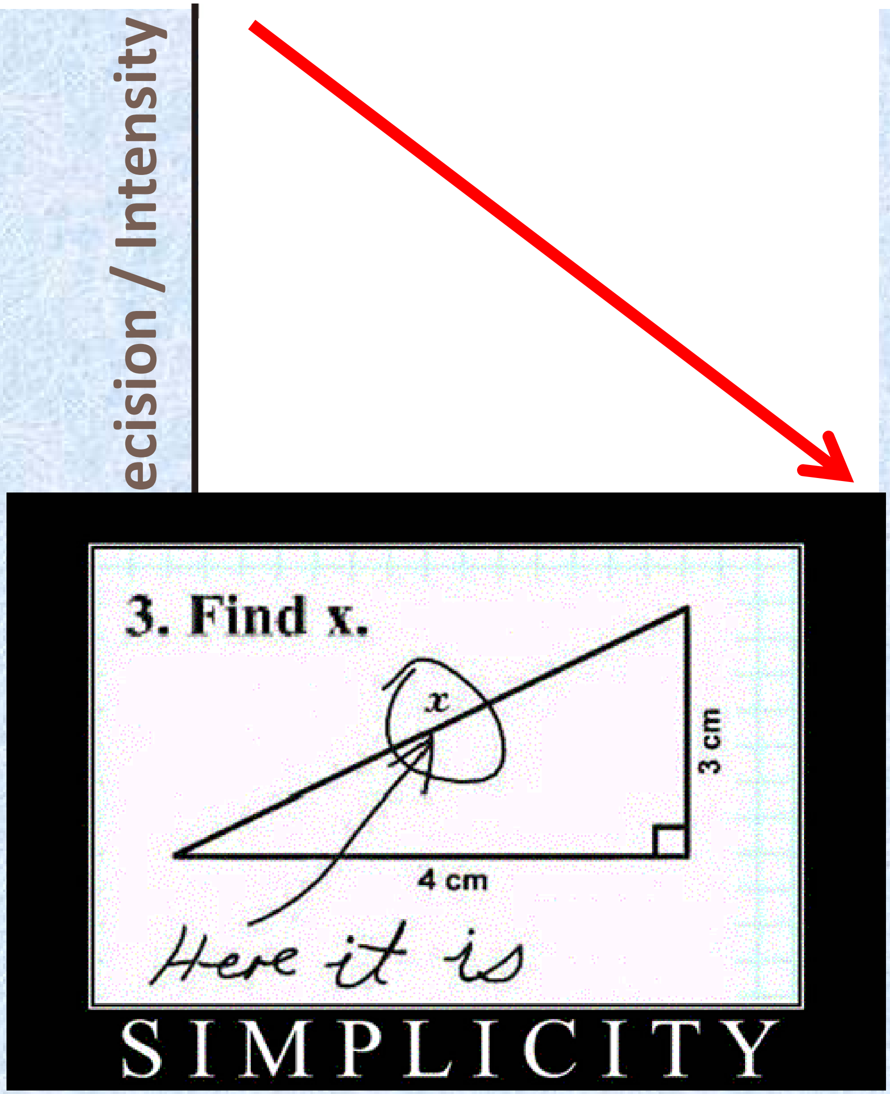
San Diego Creek Watershed SAMP



What is appropriate on existing preserved lands?

Closing Thoughts

- Choose the right tool
- Keep it simple
- Clear communication
- Move toward watershed approach



Thank You

Eric Stein
714-755-3233
erics@sccwrp.org