

## **Wetland Assessment: Measuring the Quality of the Nation's Wetlands**

By Leah Stetson, ASWM

A commonly accepted principle among architects and designers is that ‘form ever follows function,’ which means that the shape or appearance of a structure should be predicated by its intended purpose—whatever it does. But when wetland scientists talk about function, condition and values—there are different views on what these things mean and what they say about the quality of a wetland.

*Condition* describes the “health” of a wetland. The National Wetland Monitoring & Assessment Work Group’s working definition of condition is, “the state of a resource, generally reflecting a combination of physical, chemical, and biological characteristics such as temperature, water clarity, chemical composition, or the status of biological communities,” (U.S. EPA, 2007)

A wetland’s *functions* include the ecological processes or services a wetland performs generally related to habitat, hydrology and water quality. More specifically, these can be flood reduction, groundwater recharge, bank stabilization, fish and wildlife habitat. Not all wetland types perform all functions. In a watershed context, wetland functions are key factors that drive wetland restoration priorities.

Wetland *values* such as education, recreation and aesthetics, are usually addressed separately, if they are even part of an assessment. Values were historically part of wetland assessment techniques, including the 1987 Wetland Evaluation Technique (WET). In the past decade, values have been dropped from most wetland assessment methods with a few exceptions, such as Oregon Rapid Wetland Assessment Protocol (ORWAP). For more information on wetland function, values, and earlier assessment techniques, visit: <http://water.usgs.gov/nwsum/WSP2425/functions.html>

Currently there is a trend toward adopting a numerical, or metrics-based scoring system that serves to rank wetlands. Condition assessments generally provide a single rating, or score, that shows where a wetland falls on the “yard stick,” ranging from “full ecological integrity” (least impact) to “highly degraded” (poor condition). When considering function there may be a very different set of criteria to measure and evaluate wetland processes. For example, an open water pond may have low ecological integrity but provides water storage and flood control functions. A vegetated wetland may have high ecological integrity and provide habitat and biodiversity functions.

### **A National Approach: A Report Card for Aquatic Resources**

The U.S. Fish and Wildlife Service (USFWS) has measured wetland losses for half a century and subsequently produced periodic Status and Trends studies on the nation’s wetlands. These reports are based on a statistical sampling of the National Wetland Inventory maps that focus on wetland acreage. The most recent Status and Trends study (2006), reported that wetland gains exceeded wetland losses at a rate of approximately 32,000 acres per year between 1998-2004. (USFWS) The Status and Trends reports reflect wetland gains from creation and

restoration, as well as losses due to drainage, filling, diking, etc. These reports provide valuable, quantitative information about land use patterns. For more information on the USFWS Status & Trends reports, visit: <http://www.fws.gov/nwi/statusandtrends.htm>

In addition to wetland gains and losses, there has been considerable interest in learning more about wetland quality. EPA's National Aquatic Resource Surveys are underway and will continue over the next several years (to 2011) in phases. A recent phase assessed the coastal (2000-2006) and wadeable streams (2004). The 2007 survey of the nation's lakes asked, "what percentage of the nation's lakes is in good, fair and poor condition?" This survey looked at a number of factors including key indicators and stressors, e.g. pathogens, nutrients. Rivers and streams will be sampled together over the next two years, coastal areas are slated for 2010; wetlands are on the docket in 2011.

The Environmental Protection Agency (EPA) has three main goals for the National Wetlands Condition Assessment. These are 1) to produce a national report that describes the quality of the nation's wetlands; 2) to build state and tribal capacity to implement wetland monitoring and assessment programs that will guide policy development and aid project decision-making; and 3) to advance the science needed



to achieve the second objective. EPA will collaborate with the U.S. Fish & Wildlife Service (USFWS) in two main areas: the Status and Trends Reports—to detect change in wetland acreage, and on the National Wetland Condition Assessment to evaluate ambient condition of the nation's wetland resources. Taken together these two reports will provide a comprehensive ecological evaluation to support policy and management decisions. It is important to note that this national assessment will focus only on wetland condition, not function, and will serve as a broad-scale survey of the nation's wetlands. It would be very difficult to do a national survey on the basis of wetland function.

What information does a national condition assessment provide? Condition will describe the ecological and historical integrity of wetlands on a national scale. Picture a yard stick. At one end of the stick, find a mark for the least disturbed wetlands and at the far end of the stick, a notch that indicates the highest level of disturbance. It won't necessarily tell wetland managers about the floodwater retention, water quality, or values, such as education, within a community. This is one of the reasons why it is still important for states to design their own wetland assessment programs to meet their own objectives. A national "report card" does not reflect the quality of wetlands in any individual state. It does not provide site-specific information to make management decisions. States may choose to take assessment approaches that look at any combination of condition, function, values, ecological integrity, etc. in order to answer specific questions. States can use their own wetland assessments to address performance standards and set baseline data for mitigation and restoration projects. A long-term vision of EPA is to use this national condition assessment to develop state capacity so that states may develop assessments now for decision-making in the future, and to report to EPA and thus further strengthen their collaboration.

EPA's target for the national assessment will include all wetlands of the U.S., both tidal and nontidal wet areas with rooted vegetation. There will be 900 randomly-selected sites within the conterminous U.S. (plus 100 sites that will be re-sampled for QA purposes). Because it is likely that not all sites will be accessible, EPA will include a significant oversample when selecting the random sites. So, if one of the 900 is not accessible, it is then replaced with an oversample site. Including the core survey sites and oversample, there should be at least 50 random sites in each state. This should give states the option to invest additional resources to undertake a statistically-valid intensification study, according to Mike Scozzafava of the Wetlands Division, EPA. For more information on the National Wetlands Condition Assessment, visit: <http://epa.gov/owow/wetlands/survey/>

For direct access to the available EPA water quality and assessment reports, including wadeable streams, National Coastal Condition reports, updated information on the progress of the lakes assessment, as well as preliminary information about the rivers and streams assessment progress, visit: <http://www.epa.gov/owow/monitoring/reporting.html> For specific information on the National Wetland Condition Assessment, visit: <http://epa.gov/owow/wetlands/survey/>

### **Brief History of Wetland Assessment in the U.S. Since 1980s**

Wetland assessment is a fairly young application. Earlier wetland assessment methods, such as the 1987 Wetland Evaluation Technique (WET) developed by the Corps in Vicksburg, MS, offered a broad scale wetland assessment approach that evaluated a range of functions and used a matrix to rate wetlands as high, medium or low in specific categories related to function and values. Many believed that WET was a "silver bullet" in the 1980s. (Kusler, 2006)

Many of the earlier, well-established assessment models are still being used today. Indices of Biological Integrity (IBI), and similar models that look at biota, have been incorporated into states' monitoring and assessment strategies, including Maine, which uses algae and macroinvertebrates as indicators. Georgia laid the groundwork for the hydrogeomorphic (HGM) model that has been since applied to both stream and wetland assessments in different states, e.g. Oregon, California. Another assessment approach derived from the hydrologic engineering center (HEC), which is geared mainly for flood-related assessments.

Qualitative analysis of wetland functions and values grew popular a decade later and did not use numerical scoring. This descriptive approach has been used extensively within the Corps' New England district. It uses a multi-disciplinary regulatory team and applies specifically to permit applications. For more in-depth background on wetland assessment methods, see "Recommendations for Reconciling Wetland Assessment Techniques" by Jon Kusler, Esq., Ph.D. at [http://www.aswm.org/pdf\\_lib/reconciling.pdf](http://www.aswm.org/pdf_lib/reconciling.pdf)

### **State Wetland Assessment Methods**

Many states and tribes are holding discussions on how to design assessment approaches for wetlands in their states, as well as how to build on existing monitoring and assessment programs. Opinions vary when it comes to choosing function-based or condition-based assessments, or whether rapid assessments help wetland professionals obtain the desired

information to meet program objectives. Below are highlights from four states' wetland assessment approaches. There are numerous other methods that are being used.

### **Oregon. Assessment**

**Method(s):** OFWAM; HGM, ORWAP (in progress) **Type of Assessment:** Rapid Assessments--Function, Condition, Values (each addressed separately in ORWAP)  
**Assessment Tools:** Reference sites (HGM); literature and BPJ (OFWAM); literature, BPJ & some reference sites (ORWAP)



The Oregon Freshwater Wetland Assessment Method (OFWAM) (1993, 1996) assesses wetland functions, e.g. wildlife habitat, fish habitat, water quality, hydrological control, as well as values—education, recreation, aesthetics. OFWAM is very generalized and is used primarily by cities for local wetland planning and protection programs. The State of Oregon has also developed two HGM guidebooks that are used for wetland permitting (state and federal) but are not required by state regulations. Most recently, there has been a legislative commitment to develop a statewide assessment method, which Oregon is working on, according to Janet Morlan, Wetlands Program Manager at Oregon Department of State Lands. This method--the Oregon Rapid Wetland Assessment Protocol (ORWAP) will address functions, and also assess wetland condition and values, but will keep a separation between the output for functions, condition and values. The Oregon HGM classification will be incorporated into ORWAP, which will be regionalized as needed. For more information about Oregon's HGM applications, visit: [http://oregonstatelands.us/DSL/WETLAND/hgm\\_guidebook.shtml](http://oregonstatelands.us/DSL/WETLAND/hgm_guidebook.shtml) For more information on function assessments in Oregon, visit: <http://oregonstatelands.us/DSL/PERMITS/wetlanddelineation.shtml> For access to a recommendations report on developing a ORWAP go to: [http://aswm.org/pdf\\_lib/or\\_rapid\\_wetland\\_assessment\\_protocal\\_0208.pdf](http://aswm.org/pdf_lib/or_rapid_wetland_assessment_protocal_0208.pdf)

### **Montana.**

**Assessment Method(s):** Rapid (MRAM), MDOT Assessment; in process of developing an ecological integrity assessment method to replace MRAM. Three tiered strategy (landscape, rapid and intensive assessments) **Type of Assessment:** MDOT assesses function and values; MRAM assesses condition. **Assessment Tools:** Reference sites, biological indicators



Montana uses two methods of wetland assessment.

The Montana Department of Environmental Quality has a rapid method (MRAM), and the Montana Department of Transportation (MDOT) has a more detailed method. At present, MRAM is only being used sporadically. There is no systematic monitoring and assessment program. Furthermore, MRAM has a number of drawbacks, according to Linda Vance, PhD, with the Montana Natural Heritage Program. MRAM can identify a "trashed site" or even an "okay site," but does not distinguish well between excellent and good sites, mostly because it has been designed to be used by staff with minimal botanical expertise. Some of the well-known invasive species are easily spotted, so their presence can be used as a condition metric, but generally plant-based metrics require time and skill that makes them difficult to incorporate into rapid level assessments. By contrast, the MDOT assessment is

considered a good, function-based method that also takes values into account. It is used to assess wetland functions and values as a means to assign ratings to facilitate avoidance priorities, evaluate proposed disturbances and guide mitigation projects.

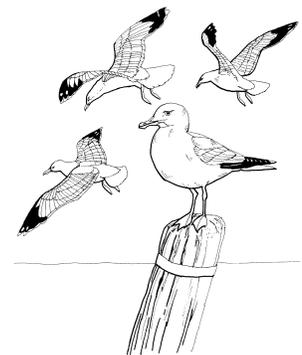


Often, the condition of a site will depend on the assessment method used. For example, Dr. Vance explained, a site may have a good degree of function even though its condition is impaired by invasive plants or hydrologic modification. Similarly, a site that has a high condition score on a rapid assessment may score lower with an intensive assessment that includes a detailed vegetation analysis. Many wetland and spring sites in Big Horn Canyon, a national recreational area, would be ranked as excellent on a rapid assessment method, but with an intensive method, the dominance of non-native watercress would "downgrade" them to very good.

The state is in the process of developing reference sites, and plans to begin systematic monitoring and assessment of wetland condition in 2009. The MRAM will likely be replaced with ecological integrity assessments being developed nationally by NatureServe and natural heritage programs. The Montana Natural Heritage Program, the Colorado Natural Heritage Program, and the Wyoming Natural Diversity Database have received an EPA grant to develop and test indicators and assessment methods in the Rocky Mountain region prior to the 2011 National Wetland Survey. For more information on ecological integrity assessments with special focus on the Rocky Mountain region, view this power point presentation, [www.natureserve.org/.../CL-7B-Developing%20Metrics%20of%20Ecological%20Integrity-Joe%20Rocchio.ppt](http://www.natureserve.org/.../CL-7B-Developing%20Metrics%20of%20Ecological%20Integrity-Joe%20Rocchio.ppt) For more information on the Montana Natural Heritage Program, visit: <http://nhp.nris.mt.gov/> . For detailed information on MRAM, go to <http://www.deq.state.mt.us/wqinfo/Wetlands/WetlandRAForm.asp> . For information on how to obtain a copy of the MDOT wetland assessment method, go to: <http://ntlsearch.bts.gov/tris/record/tris/00782269.html>

**Maine.** **Assessment Method(s):** bioassessment (combined streams & wetlands) **Type of Assessment:** ecological integrity **Assessment Tools:** Reference sites, biological indicators, e.g. algae, macroinvertebrates

Since the 1998 pilot program on bioassessment, which combined efforts to assess streams and wetlands, the state has developed two different assessment methods (one for streams, one for wetlands) The purpose of the pilot program was to expand the existing Stream Biomonitoring Program by developing wetland assessment methods; the stream program and bioassessment methods have been in place since 1983. Both look at biological communities and examine samples of macroinvertebrates and algae. Algae, in particular, may be useful in determining wetland nutrient criteria. The current wetland assessment method supports the anti-degradation policy, part of the water quality standard. One point of contention is that the 404 program's water quality standards and that of the anti-degradation policy do not always dovetail





perfectly, according to Jeanne DiFranco of the Bioassessment Program with Maine Department of Environmental Protection. Bioassessment is currently being used to support stream data, as well as wetlands, and the team will use bioassessment methods to assess the success of mitigation sites summer 2008.

Consultants do functional wetland assessments in Maine as required by the state for certain permits. The bioassessment method, however, does not assess wetland function but rather looks at biological condition and uses a narrative tiered system to classify wetlands. This tiered framework is in addition to a human disturbance score that is determined in the field and could be ratified to be used as a rapid assessment method (RAM). A Maine RAM could be based on hydrologic modifications, vegetative modifications,

evidence of chemical pollutants, potential for nonpoint source pollution and impervious surfaces in the watershed. For more information on Maine's bioassessment method, visit:

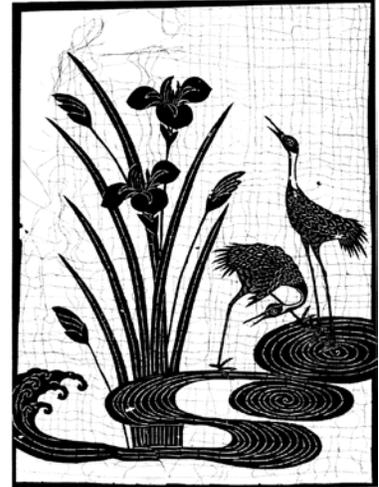
<http://www.maine.gov/dep/blwq/docmonitoring/biomonitoring/index.htm> For a sample of the wetland bioassessment field sheet, go to: [http://mainegov-images.informe.org/dep/blwq/docmonitoring/biomonitoring/materials/fieldsheet\\_wetlands.pdf](http://mainegov-images.informe.org/dep/blwq/docmonitoring/biomonitoring/materials/fieldsheet_wetlands.pdf) For a link to the *Quality Assurance Project Plan for Biological Monitoring of Maine's Rivers, Streams, and Freshwater Wetlands (Feb. 2008)*, go to: <http://mainegov-images.informe.org/dep/pubs/qapps/biomon.pdf>

The Maine Natural Areas Program has also been conducting condition-based assessments of ecological communities, including wetlands, throughout the state. Staff use a landscape-based tool and complete a more site-specific vegetative analysis in the field. The program focuses on rare ecotypes, such as peatlands, according to Kristen Puryear, a community ecologist with the Maine Natural Areas Program. An off-shoot of this is Beginning with Habitat (BWH), a cooperative, non-regulatory effort between state and federal agencies, conservation groups and regional governments in the state. The mapping component of the BWH program has wetland maps for Maine; information on these maps is available at: [http://www.beginningwithhabitat.org/the\\_maps/map1-water\\_habitat.html](http://www.beginningwithhabitat.org/the_maps/map1-water_habitat.html) For more information on the Maine Natural Areas Program activities, visit: <http://www.mainenaturalareas.org>

**Massachusetts.** **Assessment Method(s):** Landscape, Site level (SLAM), may be ratified in future to develop a rapid assessment method **Type of Assessment:** Condition and ecological integrity **Assessment Tools:** CAPS (in collaboration with U-Mass)

Coastal Zone Management (CZM) has been conducting wetland assessments for over ten years. These projects have assessed the ecological integrity of coastal wetlands. CZM has been actively involved in education, stewardship and projects that have advanced wetland assessment methods. For more information, visit: <http://www.mass.gov/czm/wastart.htm>

In March of 2006, the Massachusetts Department of Environmental Protection (MassDEP) published *Wildlife Habitat Protection Guidance for Inland Wetlands*. In the guidance, MassDEP adopted a landscape-level assessment tool developed by UMass-Amherst for use in identifying potentially important wildlife habitat. Later that year, MassDEP joined with the University of Massachusetts (UMASS) to develop a wetland monitoring and assessment strategy using the Conservation Assessment and Prioritization System (CAPS) as the central feature. This is a rigorous and sophisticated landscape-based ecological assessment methodology that has been under development at UMass for about eight years. “CAPS is being used to generate ‘Important Habitat Maps’ for use in project review and permitting to ensure that those projects affecting areas of high habitat value (high ecological integrity) get the appropriate level of scrutiny,” explained Scott Jackson, a conservation biologist with CAPS. “The comprehensive and quantitative nature of CAPS allows us to potentially address a very wide range of wetland program objectives,” added Jackson, such as prioritizing sites for enhanced regulatory protection and predicting impacts of climate change to wetlands. The project with MassDEP is now entering a second field season and will be conducted in four phases, the first of which being the on-going development of CAPS.



The second phase will be the focus of this year’s effort and will include development of a site level assessment method (SLAM—phase two) that will identify relationships between stressors, including those that are built into the CAPS landscape-level model, and wetland condition based on field data. The SLAM will include methods that are both intensive and rapid so that the stressor-condition relationships can be established and understood. This phase is projected to take 1-2 years to complete. Lisa Rhodes of the MassDEP says, “it is important that the assumptions built into the landscape-level assessment are validated by wetland condition data.” The CAPS assessment model includes stressors from areas surrounding the wetlands, whereas the SLAM, or condition assessment, will focus on stressors that can actually be observed at the sites. Having both landscape-level data and condition data, Rhodes explains, will provide a better understanding of the time lags between development and wetland degradation. For the condition assessment, the team will collect data on macrovertebrates, vegetation, soils, hydrology, water depth and area stressors. This data and the landscape-level assessment will be used to identify the reference condition. A third phase will involve developing a rapid assessment method, and long-term monitoring will be the fourth phase. For a link to the wildlife guidance, go to: <http://www.mass.gov/dep/water/laws/wldhab.pdf>

MassDEP has multiple goals for the four-phase development of the assessment methods. First, the state will be able to develop an assessment of wetlands over time that will aid in restoration as well as to help develop wetland quality standards. Second, MassDEP will be able to evaluate how construction projects affect wetlands. Third, they will be able to use the information to develop regulatory and policy-making changes, e.g. buffer zone effects.

“One other important role for landscape-based assessments is to help distinguish between ecological integrity and ecological condition and to account for time lags in the effects of landscape change on wetland condition,” Jackson says. The UMass/CAPS research team defines ecological condition as the current ecological status of an ecosystem within its ecological setting, in terms of its biophysical characteristics relative to a reference standard condition. Ecological integrity refers to the long-term capability of the ecosystem to sustain its composition, structure and function and thus also its resiliency to stress. Accounting for time lags in the way landscape change affects wetland condition, as in, how long it takes for plant and animal communities to adjust after development surrounds a wetland, as well as the ability of high-integrity wetlands to recover from episodic shifts in condition, e.g. salt truck accident in an otherwise undeveloped landscape, are two significant challenges for any wetlands monitoring and assessment program, according to Scott Jackson. For more information on CAPS, visit:

<http://www.umass.edu/landeco/research/caps/caps.html>

For a checklist of suggested considerations in developing wetland assessment methods, please go to: [http://www.aswm.org/pdf\\_lib/checklist\\_assessment\\_0208.pdf](http://www.aswm.org/pdf_lib/checklist_assessment_0208.pdf)

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For more information on wetland assessment, visit the following links:

USGS's New Ecological Assessment Methods (Searchable) Database

<http://assessmentmethods.nbii.gov/>

EPA's fact sheet on Wetland Monitoring and Assessment

<http://www.epa.gov/owow/wetlands/pdf/techfram.pdf>

USGS Wetland Assessment History

<http://water.usgs.gov/nwsum/WSP2425/functions.html>

Coastal Zone Management Wetland Assessment

<http://www.mass.gov/czm/wastart.htm> and <http://www.mass.gov/czm/wetlandassessment.htm>

University of Massachusetts' (Amherst) Conservation Assessment and Prioritization System (CAPS)

<http://www.umass.edu/landeco/research/caps/caps.html>

Developing Metrics of an Ecological Integrity Assessment

Colorado Natural Heritage Program, Joe Rocchio

[www.natureserve.org/.../CL-7B-Developing%20Metrics%20of%20Ecological%20Integrity-Joe%20Rocchio.ppt](http://www.natureserve.org/.../CL-7B-Developing%20Metrics%20of%20Ecological%20Integrity-Joe%20Rocchio.ppt)

Federal Highway Administration (FHWA) Wetland Assessment Alternatives

Dennis Durbin, FHWA

[http://www.environment.fhwa.dot.gov/conference/presentations/Durbin\\_Dennis.ppt](http://www.environment.fhwa.dot.gov/conference/presentations/Durbin_Dennis.ppt)

Federal Highway Administration (FHWA) Rapid Assessment Procedures

Brian Smith, FHWA

[http://www.environment.fhwa.dot.gov/conference/presentations/Smith\\_Brian.ppt](http://www.environment.fhwa.dot.gov/conference/presentations/Smith_Brian.ppt)

California Rapid Assessment Method (CRAM)

<http://www.cramwetlands.org/>

Montana's Rapid Assessment Method

<http://www.deq.state.mt.us/wqinfo/Wetlands/WetlandRAForm.asp>

Oregon Wetland Assessment Manual

[http://www.oregon.gov/OWEB/docs/pubs/wa\\_manual99/05\\_rip\\_wet\\_print.pdf](http://www.oregon.gov/OWEB/docs/pubs/wa_manual99/05_rip_wet_print.pdf)

Maine Wetland Assessment Bioassessment

<http://www.maine.gov/dep/blwq/docmonitoring/biomonitoring/index.htm>

Beginning with Habitat (Maine)

<http://www.beginningwithhabitat.org/index.html>

Maine Natural Areas Program

[http://www.mainenaturalareas.org/docs/program\\_activities/](http://www.mainenaturalareas.org/docs/program_activities/)

Army Corps of Engineers Reports on Hydrogeomorphic Wetland Assessment

<http://el.erdc.usace.army.mil/wetlands/guidebooks.html>

Ohio EPA's Assessment reports

[http://www.epa.state.oh.us/dsw/wetlands/WetlandEcologySection\\_reports.html](http://www.epa.state.oh.us/dsw/wetlands/WetlandEcologySection_reports.html)

Ohio EPA's An Ecological and Functional Assessment of Urban Wetlands in Central Ohio Vol. 1: Condition of Urban Wetlands using Rapid & Intensive Assessment Methods by John Mack and Mick Micacchion

[http://www.epa.state.oh.us/dsw/wetlands/L919ReportVol\\_1\\_EcologAssessUrbanWTLDs.pdf](http://www.epa.state.oh.us/dsw/wetlands/L919ReportVol_1_EcologAssessUrbanWTLDs.pdf)

Louisiana Wetland Monitoring and Assessment of Restoration

<http://www.gao.gov/new.items/d08130.pdf>

### **Recommendations for Reconciling Wetland Assessment Techniques**

Jon Kusler, Esq., Ph.D. Association of State Wetland Managers, Inc.

[http://www.aswm.org/pdf\\_lib/reconciling.pdf](http://www.aswm.org/pdf_lib/reconciling.pdf)

### **Wetland Assessment Report Series:**

Jon Kusler, Esq., Ph.D. Association of State Wetland Managers, Inc.

#### **Wetland Assessment for Regulatory Purposes**

[http://www.aswm.org/pdf\\_lib/assessing\\_functions\\_values.pdf](http://www.aswm.org/pdf_lib/assessing_functions_values.pdf)

**Wetland Assessment for the Courts** [http://www.aswm.org/pdf\\_lib/assessment\\_courts.pdf](http://www.aswm.org/pdf_lib/assessment_courts.pdf)

#### **Integrating Wetland Assessment Into Regulatory Permitting**

[http://www.aswm.org/pdf\\_lib/integrating\\_assessment\\_permitting.pdf](http://www.aswm.org/pdf_lib/integrating_assessment_permitting.pdf)

### **Application of Elements of a State Water Monitoring and Assessment Program for Wetlands**

EPA, April 2006 This document includes the recommended elements of a state water monitoring and assessment program. <http://www.epa.gov/owow/wetlands/monitor/#elements>

### **A Practical Guide for the Development of a Wetland Assessment: the California Experience**

Martha A. Sutula, Eric D. Stein, Joshua N. Collins, A. Elizabeth Fetscher, and Ross Clark

[http://www.wrmp.org/docs/cram4/WREB4201\\_157-175.pdf](http://www.wrmp.org/docs/cram4/WREB4201_157-175.pdf)

### **An evaluation of wetland assessment techniques and their applications to decision making**

MA Thiesing, EPA

<http://www.environment.gov.au/ssd/publications/ssr/pubs/techniques-ssr161.pdf>