

**WETLAND CONDITION  
ASSESSMENT: DEVELOPING  
RAPID PROCEDURES**



W.B. Sutton  
Advanced Wetlands Ecology, WFS 536  
09/08/2011

Photos: D. Osborne

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**Outline**

1. Understand advantages and limitations of rapid bioassessment approaches
2. Delineate and assign reference conditions based on study objectives
3. Understand how to calibrate and evaluate results from rapid assessments

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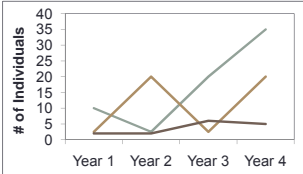
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**Biological Monitoring**

- What is the basis of biological monitoring
  - Detect positive and negative trends
- Can be difficult to know the nature of some trends
- Long-term data-sets are often required



Year	Series 1 (Blue)	Series 2 (Orange)	Series 3 (Green)
Year 1	10	5	5
Year 2	5	20	5
Year 3	10	5	10
Year 4	35	20	5

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### About data quality

Strength of Inference

Strong

Manipulative Experiments

Constrained Design Studies

Weak

Observational Studies  
- *a priori* hypotheses  
- *a posteriori* hypotheses

Manipulative Data Best!

BUT

Not Always the Best Option

1. Feasibility  
2. Past Disturbance

so how.....

Anchor w/ reference

D. Mackenzie, pers. comm. (2011)

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### Biological or Condition Assessment Techniques

- A general class of monitoring techniques that can be used to evaluate the ecological condition of a particular site.
- Intensive and non-intensive approaches (Index of Biological Integrity, Rapid Approaches, Basic Checklists)
- Generally a final assessment approach will involve multiple assessment methods

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### Bioassessment Planning

1. Clearly establish monitoring objectives and identify appropriate indicators
2. Establish gradient
3. Define overall scale
4. Designate reference conditions (wetland types)
5. Determine appropriate level of data resolution
6. Develop and calibrate rapid assessments tools

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### Wetland Condition Indicators

- Habitat structure, diversity, complexity
- Species complexity
- Hydrology or geomorphology
- Biogeochemistry or water quality
- Landscape context
  - Connectivity
  - Buffers



E. Stein, pers. comm. (2011)

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### Condition Gradient

- Gradient can represent disturbance, forest age, etc.
  - GIS, used to determine disturbance
- Varies greatly on objectives
- Should encompass all stages of gradient
- Increase strength of overall condition assessment



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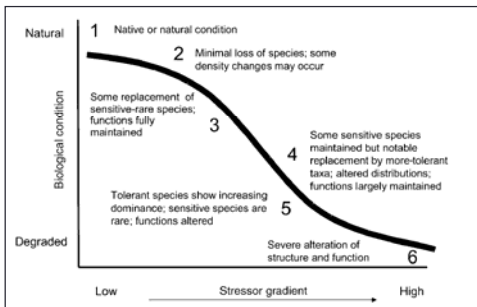
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### General Stressor Gradient



Davies and Jackson 2006

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### Assessment Scale

- Determined by assessment objectives
  - Single wetland type; multiple types
  - Probabilistic sampling design
  - Incorporate regional and other stratifications
- Greatly impacts study design
  - (Watershed, state, geographic province, national)
- As scale increases, study design gets extremely complex

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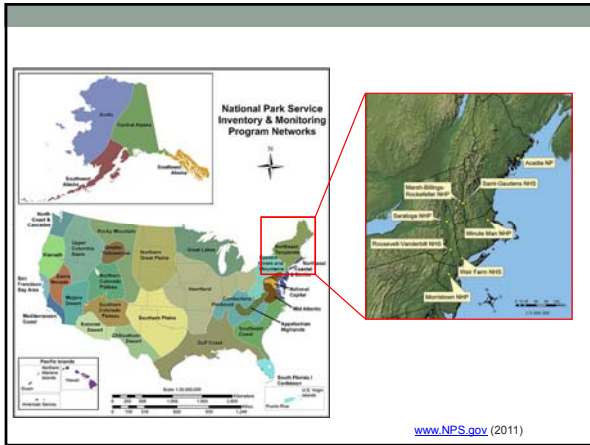
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### Reference Sites

- What do they represent?
  - True pristine condition
  - Best relative condition
  - Depends highly upon objectives



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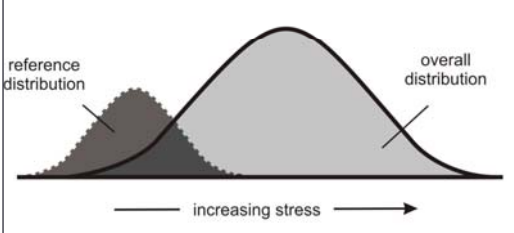
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E. Stein, pers. comm. (2011)

### Reference sites

- Empirical
- Modeled
- Expert judgment



The graph shows two overlapping normal distributions. The smaller, darker distribution on the left is labeled 'reference distribution'. The larger, lighter distribution on the right is labeled 'overall distribution'. An arrow at the bottom points from left to right, labeled 'increasing stress'.

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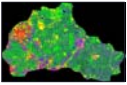

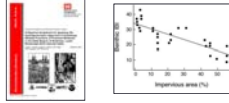
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### General bioassessment approaches

- **Level 1:** Landscape Assessments (e.g., remotely-sensed data)
  - No field component
  - Calibration necessary
- **Level 2:** Rapid Field Methods (e.g., rapid assessments)
  - Field component
  - Calibration necessary
- **Level 3:** Intensive Field Methods (e.g., IBI and HGM approach)
  - Field Component
  - Used to Calibrate Levels 1 and 2

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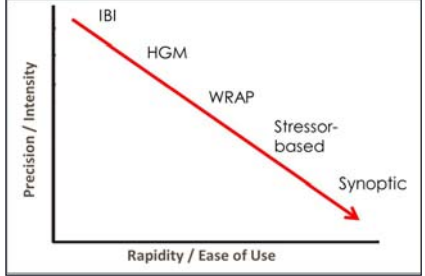
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### Continuum Of Condition Assessments



The graph plots 'Precision / Intensity' on the vertical axis against 'Rapidly / Ease of Use' on the horizontal axis. A red arrow points from the top-left towards the bottom-right, indicating a trade-off. Along this arrow, several assessment methods are labeled: IBI (at the top-left), HGM, WRAP, Stressor-based, and Synoptic (at the bottom-right).

E. Stein, pers. comm. (2011)

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## Index of Biological Integrity

- Organismal based bio-assessment
  - Species richness
  - Various measures of species composition
- Stress is integrated within the assessment
  - but may be difficult to identify source of stress
- Detailed surveys (multiple visits) are necessary (detection)
- Multiple metrics can be combined to produce final IBI

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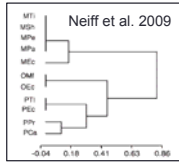
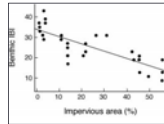
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## IBI calculation

- Wetlands are classified into category classes (BPJ)
  - Cluster analysis
- Cutoff values are assigned (i.e., 1 – 3)
  - lower values indicate lower condition
- Scores are summed to create overall site score



Metric	Score 0	Score 1	Score 2	Score 3
Age	<10	10-14	15-18	>18
Red Abundance	0%	10-100%	10-400%	>10%
Red Abundance Class	0%	10-100%	10-10%	>10%
% of Red Cherting	0-1	2	3	>3
Optimal Substrate in	absent	-	-	present

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Photos: D. Osborne, W. Sutton, E. Stein

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## Hydrogeomorphic Approach

- Functional-based assessment
  - Functions are derived via multiple indicators
- Distinct Classification
- Functions difficult to formulate
  - HGM manuals per region
- Scores easily determined once function relationships are identified.




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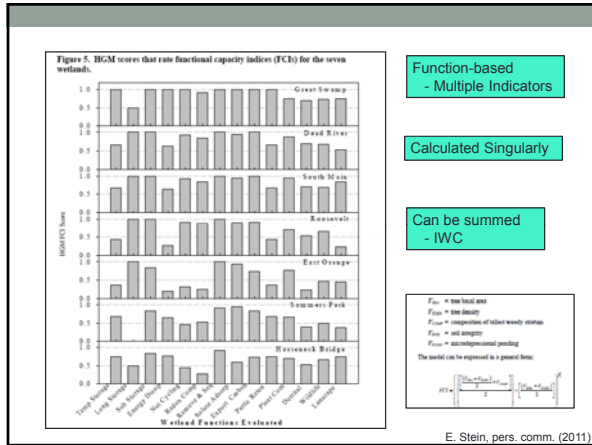
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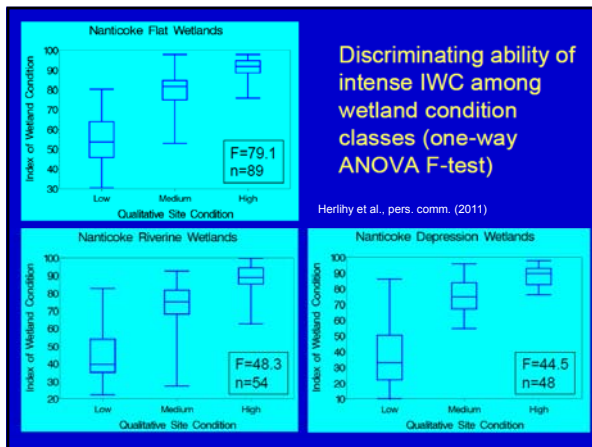
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### What are Rapid Approaches?

- Abbreviated condition assessments
  - Generally < 0.5 day survey time
  - Semi-quantitative; categorical data
  
- Overall score obtained by summing individual categories
  
- Ecosystem functions are contained within each assessment category

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### Rapid Approaches

- Level 2 rapid approaches (semi-quantitative)
  - Ohio Rapid Assessment Method
  - California Rapid Assessment Method
  
- Series of rapid questions drive the assessment (vary from presence/absence to estimation covariates)
  
- Simplified Rapid Assessment Technique (i.e., DERAP)
  - Stressors are noted during survey
  - Plots lose points as stressors increase
  
- Stressors can be weighted depending on objectives

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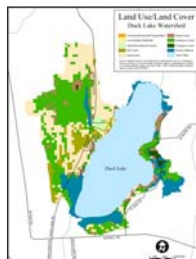
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### Remotely-Sensed Rapid Approaches

- Generally known as synoptic approaches
  
- No field component required
  
- Landuse data
  - Buffer hits
  
- Must also be calibrated using more detailed approach



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USEPA 2011

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**Table 3. Metrics in quantitative rating and the partitioning of the score**

Metric	Title	submetric	submetric maximum	metric maximum	% total score each metric
1	Wetland Size	None	6	6	6%
2	Upland buffers and surrounding land use	2a Average buffer width	7	14	14%
		2b Surrounding Land Use	7		
3	Hydrology	3a Sources of Water	11	30	30%
		3b Connectivity	3		
		3c Maximum water depth	3		
		3d Duration inundation or saturation	4		
		3e Modifications to natural hydrologic regime	12		
4	Habitat alteration and development	4a Substrate Disturbance	4	20	20%
		4b Habitat development	7		
		4c Habitat alteration	9		
5	Special Wetland Communities	None	10+10	10	10%
6	Vegetation, Interspersion, Microtopography	6a Wetland vegetation communities	18	20	20%
		6b Horizontal community interspersion	5		
		6c Presence of Table 1 Invasives	-5		
		6d Microtopography	12		

Ohio Rapid Assessment Method Mack (2001)

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**FORM USEPA 2. STRESSORS IN BUFFER AREA (Form)**

Site ID: NWCA11 Date: 9/8/11

Metric 2: Stressors based on observations of the 100m area surrounding the AA. Only those collected on all but one whether or not they count as buffer or Metric 1. Fill in the buffer corresponding to the choice for each stressor indicator that is observed on the guidelines below. They provide an overall rank for each Stressor Category.

Portion of 100m Buffer Zone surrounding AA:

100% (0-300m) \_\_\_\_\_  
 Between one third and two thirds \_\_\_\_\_  
 At least two thirds \_\_\_\_\_

Field indicators by Stressor Category

Field indicator present, mark its severity (1-3)	Hydrological Stressors	Residential/Urban/Commercial Stressors
0 1 2 3	Obstructions/blockages	Suburban residential land use
0 1 2 3	Obstructions/blockages/natural or modified	Urban residential
0 1 2 3	Culverts, pipes (point source discharges) in the buffer zone	Urban commercial buildings
0 1 2 3	Water used control structures	Road, gravel
0 1 2 3	Obvious spills, discharges or odors, unusual water color or taste	Road, (oil) driveway
0 1 2 3	Blockages to heavy formation of flammable gases	Pool, (hot) tub
0 1 2 3	Excavation: standing	Pool, (hot) tub
0 1 2 3	Fill/sediment	Pool, (hot) tub
0 1 2 3	Wetlands	Pool, (hot) tub
0 1 2 3	Beams and culverts	Pool, (hot) tub
0 1 2 3	Impervious surface input	Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub
0 1 2 3		Pool, (hot) tub

National Wetland Condition Assessment USEPA (2011)

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Appendix C. Stressor Weights

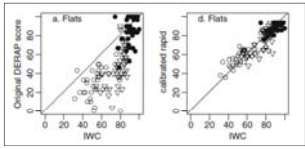
updated May 15, 2006

Description	Weights		
	Flats	River	Dep
<b>Disturbance Category</b>			
Mowing in AA			
Farming activity in AA			53.1
Clearing in AA			
No forestry activity within 50 years			
Forestry activity 20-50 years	7.3	6.3	
Forestry activity 15-20 years			
Forestry within 15			
Forestry activity < 10% of site			
Clear cut in AA	22.0	10.1	
Clearcut land not recovering			53.1
Excavation Herbivory/Predate/ Bumble/Colony			
Invasive spp. dominating site			23.4
Poplars not dominating			
Channel Disturbance			57.2
Managed or converted to Past	5.9		
Drainage			
Flats			
Overage/Toxical Dumping			49.9
Nutrients direct application/ runoff			
Nutrients direct argal mats			
Logging road in AA			
Dist or stream road in AA			
Private road in AA			

Weights can be assigned to each stressor  
 - Based on variable importance  
 - Statistical methods optimal

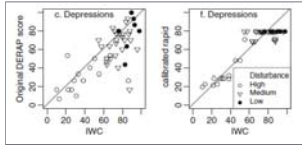
Delaware Rapid Assessment Method  
 Jacobs (2006)

### Model Calibration (Examples)



DERAP Method:  
 Stressor-based method  
 Correlated with IWC

Calibration:  
 $IWC = A + B_1X_1 + B_2X_2 \dots + B_nX_n$   
 A = Intercept  
 $B_j$  = Regression coefficient  
 $X_j$  = Stressor



Herlihy et al. 2010

### Model Calibration (Continued)

- Run multiple regression iterations (stressor combinations)
- Model selection techniques (Akaike's Information Criterion)
  - o  $AIC = -2 \ln L(\theta) + 2K$
  - o Evaluate fit of each model (Akaike's weights [ $\omega_j$ ])
  - o Model averaging for highest supported models
    - $\theta = \Sigma \omega_j \theta_j ; \omega_j =$  weight for particular model
    - $\theta_j =$  Regression coefficient for parameter
- Use model regression coefficients as weights to adjust rapid model parameters

### Model Evaluation and Calibration

- Necessary and essential steps
  - Multiple version of rapid assessments
- Rapid assessment methods are not stand-alone
  - Must be paired with a detailed level 3 approach
- Wetland ecosystems are dynamic environments
  - As the ecosystems change, so should your models

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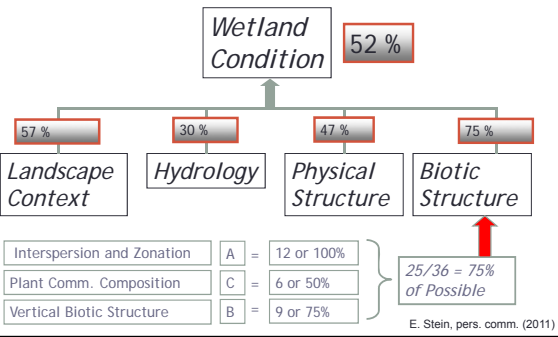
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### Evaluation: California Rapid Assessment Method



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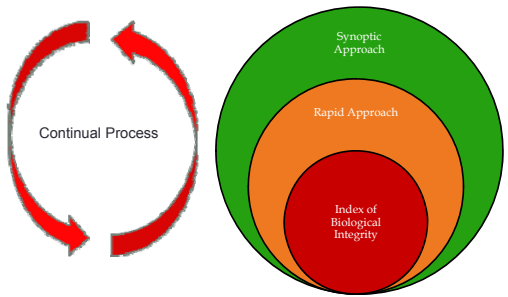
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### Model Evaluation and Calibration



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### Model Validation

- Overall model accuracy...
  - Signal to noise ratio?
  - Does evaluation assign appropriate scores?
- Can method cover the range of disturbance?
- How redundant are the components?
- How reproducible are the results?
  - Can different evaluators arrive at the same result?
  - Variation associated with observers...

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### Points for Consideration

- Multiple methods are often necessary for developing a rapid assessment approach
- Significant effort should be allocated during the planning process
  - Well-established and distinguishable gradient
  - Scale
  - Reference Conditions
  - Stratifications (region, wetland type)

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### Points for Consideration

- A working feedback loop should be established for model evaluation and validation
  - Model re-assessment should occur regularly
  - Rapid assessments useful, but need constant evaluation
- Clear understanding of monitoring objectives
- **Questions drive assessments!**
  - “An approximate answer to the right question is worth a great deal more than a precise answer to the wrong question.”
  - John Tukey

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