Establishing a Probabilistic Stream, Lake and Ground Water Monitoring Network in Florida: Lessons Learned

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Florida Department of Environmental Protection
WHY MONITOR WATER QUALITY?
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CLEAN WATER ACT
[U.S. Congressional Statutes 1315(b) - 305(b)]

“Each State Shall Prepare and Submit...a Report Which Shall Include a Description of Water Quality of all Navigable Water...”
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[Florida Statutes, Chapters 376 and 403]
Authorizes Florida DEP to require permittees to monitor water quality.
WHY MONITOR WATER QUALITY?

FLORIDA WATER POLICY, Chapter 62-40.540:

“The Department Shall Coordinate Department, District, State Agency, and Local Government Water Quality Monitoring Activities to Improve Data (Quality) and Reduce Costs...”
RECENT STATEWIDE MONITORING EFFORTS:
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Surface Water Ambient Monitoring Program (SWAMP):

• Cooperative effort comprised of state, water management district and county monitoring efforts;
• Approximately 485 fixed stream and lake sampling stations;
• Conflicting goals, sampling frequency and analytes;
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Ambient Ground Water Monitoring Program (AGWMP):
- Cooperative effort comprised of state, water management district and county monitoring efforts;
- Approximately 1200 “Background Network” fixed well and spring sampling stations;
- Consistent analyte list, sampling methodology, one lab;
- Inconsistent sampling frequency, goals too generalized.
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- Consistent analyte list, sampling methodology, one lab;
- Inconsistent sampling frequency, goals too generalized;

- Networks combined and re-structured beginning in July, 1996
Components of a Water-Quality Monitoring System
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- Information Goals
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- Information Goals
- Experimental Design
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- Information Goals
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Components of a Water-Quality Monitoring System

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- Data Management and Review
## Components of a Water-Quality Monitoring System

<table>
<thead>
<tr>
<th>Information Goals</th>
<th>Data Management and Review</th>
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<tbody>
<tr>
<td>Experimental Design</td>
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<td>Reporting</td>
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Components of a Water-Quality Monitoring System

- Information Goals
- Experimental Design
- Sample Collection
- Lab Analysis

- Data Management and Review
- Data Analysis
- Reporting
- Information Utilization
INTEGRATED WATER RESOURCE MONITORING NETWORK (IWRM):

GOAL:
INTEGRATED WATER RESOURCE MONITORING NETWORK (IWRM):

**GOAL:**

“To provide scientifically defensible, statewide data and information on the important chemical, physical and pertinent biological characteristics of water, including sediments, from the major surface water bodies, the major aquifer systems, and the coastal waters of the state. The information generated by the integrated network is to be the basis for reporting and advising relevant Departmental and other governmental agencies on the status and trends of Florida’s water quality”
INTEGRATED WATER RESOURCE MONITORING NETWORK (IWRM):

OBJECTIVES:
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1) Identify, document and predict the conditions of Florida’s water resources. Assist in determining the status of an ecosystem’s “environmental health”;
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OBJECTIVES:

1) Identify, document and predict the conditions of Florida’s water resources. Assist in determining the status of an ecosystem’s “environmental health”;

2) Establish the water quality of relatively “pristine” aquatic reference sites for comparison with affected surface and ground waters and ecosystems;

3) Document potential problem areas;
INTEGRATED WATER RESOURCE MONITORING NETWORK (IWRM):

OBJECTIVES (continued):

4) Identify water quality changes over time in pertinent water bodies;
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5) Provide information to managers, legislators, agencies and the public;
OBJECTIVES (continued):

4) Identify water quality changes over time in pertinent water bodies;

5) Provide information to managers, legislators, agencies and the public;

6) Determine the proportion of the state’s water bodies that meet water quality criteria.
STATUS MONITORING NETWORK

Purpose:
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1) Characterize regional to statewide water resource conditions, using a rotating basin, multi-year probabilistic sampling approach;
STATUS MONITORING NETWORK

Purpose:

1) Characterize regional to statewide water resource conditions, using a rotating basin, multi-year probabilistic sampling approach;

2) Determine how conditions change over time for each monitored resource;
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1) Characterize regional to statewide water resource conditions, using a rotating basin, multi-year probabilistic sampling approach;

2) Determine how conditions change over time for each monitored resource;

3) Determine percentage of each resource within each basin which meets standards (ground water) or designated use (surface water).
STATUS NETWORK MONITORING STRATEGY

- Divide state into 5 regions – by water management district
STATUS NETWORK MONITORING STRATEGY

• Divide state into 5 regions – by water management district

• Subdivide each water management district (WMD) into four “Reporting Units” (RU’s). Label each RU “A”, “B”, “C” and “D”. Each RU consists of one or more basins, or Hydrologic Units (U.S. Geological Survey “HUC’s”)
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  Year 1 - Randomly sample one RU - “C”
  Year 2 - Randomly sample one RU - “A”
  Year 3 - Randomly sample one RU - “B”
  Year 4 - Randomly sample one RU - “D”
  Year 5 - Randomly sample either “A,B,C, or D” (enables estimate of temporal variance)

For example, sample “C” in Year 5
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  For example, sample “C” in Year 5

- Do not sample same basin two consecutive years
For Each Year in Each Reporting Unit:

Collect 30 random samples from 6 water resources:
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1) Wadeable Streams
For Each Year in Each Reporting Unit:

Collect 30 random samples from 6 water resources:

1) Wadeable Streams
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For Each Year in Each Reporting Unit:

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3) Small Lakes (< 10 hectares)
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*Collect 30 random samples from 6 water resources:*

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3) Small Lakes (< 10 hectares)
4) Large Lakes (> 10 hectares)
5) Unconfined Aquifers & Springs
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Collect 30 random samples from 6 water resources:

1) Wadeable Streams  
2) Non-Wadeable Streams & Canals  
3) Small Lakes (< 10 hectares)  
4) Large Lakes (> 10 hectares)  
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6) Confined Aquifers
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7) Estuaries - conducted by Florida Marine Research Institute (FMRI)
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9) Sediments – no sampling at this time
# Current Status Network Analyte List

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>LAKES</th>
<th>STREAMS</th>
<th>AQUIFERS</th>
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<td>T</td>
<td>D</td>
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<tr>
<td>Magnesium</td>
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<td>Depth to Water (from LSE)</td>
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<td>Microlanduse</td>
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T = total sample  
D = dissolved sample  
X = other sample or measurement
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<tr>
<th>Month</th>
<th>Confined Aquifer</th>
<th>Unconfined Aquifer</th>
<th>Low Order Streams</th>
<th>High Order Streams</th>
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<th>Large Lakes</th>
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</table>

N = North Florida (NWFWMD, SRWMD); P = Peninsular Florida (SJRWMD, SFWMD, SFWMD)

*Primary Index Period*  
*Overflow Index Period*

* Total does not include QA samples
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #1: 20 statewide “Reporting Units” do not match up aerially or temporally with Florida’s TMDL Basins.
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  20 statewide “Reporting Units” do not match up aurally or temporally with Florida’s TMDL Basins.

• SOLUTION:
  1) Adopt TMDL’s 30 basins. This will result in an increase (4500 vs. 3600) in number of samples collected during the second basin rotation cycle;
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• PROBLEM #1:
  20 statewide “Reporting Units” do not match up aerially or temporally with Florida’s TMDL Basins.

• SOLUTION:
  1) Adopt TMDL’s 30 basins. This will result in an increase (4500 vs. 3600) in number of samples collected during the second basin rotation cycle;
  2) Sample basins 18 – 24 months prior to initiation of TMDL basin assessments (second cycle).
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #2:
  Many stream sites mis-identified as high- or low-order streams, using the current RF3 1:100,000 base map.
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• SOLUTION:
  1) Move to 1:100,000 National Hydrography Data (NHD) base map for selection of second cycle rotating basin sites;
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• SOLUTION:
  1) Move to 1:100,000 National Hydrography Data (NHD) base map for selection of second cycle rotating basin sites;
  2) Develop in-house capabilities for making random site selections;
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #2:
  Many stream sites mis-identified as high- or low-order streams, using the current RF3 1:100,000 base map.

• SOLUTION:
  1) Move to 1:100,000 National Hydrography Data (NHD) base map for selection of second cycle rotating basin sites;
  2) Develop in-house capabilities for making random site selections;
  3) Re-define high-order and low-order streams by designating certain specific “major rivers” as a separate stream resource.
• PROBLEM #3: Chemistry-based sampling alone does not allow for accurate determination of percentage of streams meeting “designated uses” (potable water supplies, shellfish propagation or harvesting, recreational use, agricultural water supplies, and navigation / utility / industrial use).
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #3:
  Chemistry-based sampling alone does not allow for accurate determination of percentage of streams meeting “designated uses” (potable water supplies, shellfish propagation or harvesting, recreational use, agricultural water supplies, and navigation / utility / industrial use).

• SOLUTION:
  Move to bio-reconnaissance as the major stream assessment tool. BioRecons include habitat assessment, dip-net sweeps and some chemistry (field analytes, nutrients).
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #4:
  “Designated Use” of Florida’s potable aquifer systems is defined by statute as drinking water. Analyte list for ground water sites does not sufficiently address Primary and Secondary drinking water standards, or indicators of concern.
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #4:
  “Designated Use” of Florida’s potable aquifer systems is defined by statute as *drinking water*. Analyte list for ground water sites does not sufficiently address Primary and Secondary drinking water standards, or indicators of concern.

• SOLUTION:
  Adjust analyte list to include all Primary and Secondary standards. Add analytes of concern in Florida’s potable aquifer systems (Sr, Ra or gross alpha, fecal coliform in unconfined aquifer systems, Fe, Mn, Al).
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #5: Current well selection results in “clustering” of sampling sites (closest well / spring to 30 randomly determined locations in each reporting unit).
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  Current well selection results in “clustering” of sampling sites (closest well / spring to 30 randomly determined locations in each reporting unit).

• SOLUTION:
  1) Move to “random sampling within grids”:
     establish 50-60 grid cells / reporting unit, and randomly select a well within each grid cell. Grids will be sampled in random order. Grid cells without wells will be skipped.
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

- PROBLEM #5:
  Current well selection results in “clustering” of sampling sites (closest well / spring to 30 randomly determined locations in each reporting unit).

- SOLUTION:
  1) Move to “random sampling within grids”: establish 50-60 grid cells / reporting unit, and randomly select a well within each grid cell. Grids will be sampled in random order. Grid cells without wells will be skipped.
  2) Add additional wells / springs to the candidate “list frame”.
PROBLEMS Encountered in First Basin Rotation Cycle:

• Problem #6:
  Proposed new five-year, 30 rotating basin sampling regimen does not allow for re-sampling of randomly-selected basins in order to determine temporal variance.
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #6:
  Proposed new five-year, 30 rotating basin sampling regimen does not allow for re-sampling of randomly-selected basins in order to determine temporal variance.

• SOLUTION:
  Use data from Florida DEP’s fixed station Surface Water and Ground Water Temporal Variability Networks to estimate variance.
PROBLEMS ENCOUNTERED IN FIRST BASIN ROTATION CYCLE:

• PROBLEM #7:
  Many network and sampling problems have required adjustments to be made in mid-cycle (not good).
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• PROBLEM #7:
  Many network and sampling problems have required adjustments to be made in mid-cycle (not good).

• SOLUTION:
  Dispense with the “fifth year” in the first cycle, and move directly to the second cycle, with implementation of all remaining problem fixes beginning in January, 2004.
Surface Water Temporal Variability (SWTV) Monitoring Network
SURFACE WATER TEMPORAL VARIABILITY NETWORK:

- **GOALS:**

  - Correlate Status Network monitoring results (“Tier I Basin Characterization”) with hydrographic period;
  - Estimate general basin-wide loading;
  - Make best temporal estimates of variances of parameters for HUC’s.
SURFACE WATER TEMPORAL VARIABILITY NETWORK:

SITE SELECTION & MONITORING CRITERIA:

- Primarily monitor only one resource: non-tidal, non-wadeable rivers;
- Select sampling sites at lower end of HUC basins;
- Collect flow data at or proximal to sampling sites (recorder station or staff gage);
- Preference for TREND sites with existing long-term historic water quality and/or flow records;
- Reasonable site access;
SURFACE WATER TEMPORAL VARIABILITY NETWORK:

- SITE SELECTION & MONITORING CRITERIA:
  
  - At least one SWTV site per HUC;
  
  - Sampling stations should be located near the state line on major rivers entering Florida from Georgia and Alabama;

  - SWTV stations should be nested within Status Network sites;
SURFACE WATER TEMPORAL VARIABILITY NETWORK:

**ADDITIONAL NOTES:**

- *Revised SWTV Network not designed to monitor point pollution sources;*
- *SWTV sites should be initially sampled at least monthly;*
- *Analyte list same as for Status Network sampling sites.*
Ground Water Temporal Variability (GWTV) Monitoring Network
Ground Water Temporal Variability Network

PURPOSE:

- Correlate “Status Basin Characterization” with seasonal hydroperiod;

- Estimate temporal variance of sampled analytes within each Reporting Unit.
SITE SELECTION:

- Resources to be monitored:
  * unconfined aquifers;
  * confined aquifers;

- Number of monitoring sites:
  * at least one unconfined aquifer monitoring well per reporting unit;
  * at least one confined aquifer monitoring well per reporting unit.
MONITORING CRITERIA:

- Sampling frequency:
  * unconfined aquifers: *monthly*;
  * confined aquifers: *quarterly*;

- Analytes to be measured:
  * Status Network analyte list (field + lab) in 5 reporting units sampled as part of the Status Network during each year;
  * Field analytes only in 15 reporting units not sampled as part of the Status Network during each year.