COUNTY FACULTY IN-SERVICE TRAINING
FOR WATER SAMPLING AND CHEMICAL ANALYSIS

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Abstract. The objective of the in-service training for extension personnel with responsibilities in agriculture, horticulture and natural resources was to introduce field concepts and applications related to environmental evaluation of surface water and groundwater. Training focused on advanced technology of water chemistry and hydrology related to water sampling and monitoring techniques, instrumentation, water quality data analysis and evaluation, and reporting. The training was a combination of lectures, hands-on laboratory activities, and field tours. Several water quality monitoring programs in south Florida were presented. Various water sampling methods were demonstrated. Participants measured water quality using quick testing kits and sophisticated instruments.

The water quality in-service training for county faculty with responsibilities in agriculture, horticulture and natural resources was held on 23-24 Mar. 2006, at the University of Florida, IFAS, Tropical Research and Education Center (TREC), Homestead, Fla. The in-service training was designed to meet needs of county extension faculty and focused on water sampling and chemical analysis. Most of extension agents throughout Florida would benefit from additional knowledge regarding water quality monitoring due to the implications of water quality monitoring to their clientele with regards to Best Management Practices (BMPs) and Total Maximum Daily Loads (TMDLs). Currently, BMPs have been developed or are being developed for many crops by commodity and region in Florida. Many county extension agents are involved in BMP development and implementation. BMPs often are designed to offer water related benefits, specifically reducing water quantities used and minimizing the polluting of water bodies.

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Fig. 1. Lectures to teach basic concepts of hydrology, TMDL, BMP, water sampling and monitoring techniques, instrumentation, water quality data analysis and assessment.
The next stop of the tour was South Florida Water Management District (SFWMD) pump station 331. Mr. Ray Garza, the pump station supervisor explained the purpose of the station and gave a tour of the control room and pumps. Participants also collected canal water using a bailer following instructions from Dr. Wang and Mr. Campbell.

The in-service attendees also visited the Everglades National Park (ENP). At the ENP, participants spoke with Robert Johnson, Director of South Florida Natural Resource Center at the park. Dr. Johnson explained historical changes of the park and challenges of water quality facing by the park.

Collecting surface water samples from Everglades’s wetland was the most interesting and exciting exercise of this in-service training. Participants had to take a speedy airboat ride to get to the marsh area and collected samples on the boat while alligators were swimming nearby (Figs. 3 and 4).

Lunches and a dinner together gave agents additional time and opportunity to discuss water quality issues and the daily challenges of extension job with the colleagues from other counties.

The second day of the workshop was analyzing water samples collected by participants (Fig. 5). Three samples (Hoagland-low, Hoagland-high, Distilled-deionized water-DDI) were prepared by the Soil and Water Laboratory and also included in analysis by participants.

All participants were divided into 4 groups for learning chemical analysis from 4 different stations with various analytical instruments and techniques (Table 2). Each station had well-trained, skilled laboratory technician assigned to it to work with the participants.

Data generated from each group were analyzed statically using a SAS program and the score method to demonstrate variation among analytical methods. Statistical analyses mod-
ified from Lin and Niu (1998) were adopted to evaluate different methods (i.e., quick test kits, IC, Auto analyzer, and AAS) used for determining the selected water quality variables. Below are the two steps included in the procedure (Table 3).

1) Testing for outliers. Outliers refer to those observations which much higher or lower than most of the data. For each data set, the outlier-determination equation is:

\[ U_L = a_{1/4} - 1.5 \times (a_{3/4} - a_{1/4}) \]

\[ U_U = a_{3/4} - 1.5 \times (a_{3/4} - a_{1/4}) \]

where \( U_L \) and \( U_U \) are the lower and upper outlier bound, \( a_{1/4} \) is the 25th percentile, and is the 75th percentile.

Observations lower than \( U_L \) or higher than \( U_U \) were treated as outliers. Data sets containing outlier(s) were excluded from the calculating of Cook-Weisberg distance.

2) Calculating the Cook-Weisberg distance (C-W distance) (Lin and Niu, 1998). C-W distance measures the distance between observations and centroid as follows:

\[ D_I = \frac{r(\bar{Y}_I - \bar{Y})^2}{p \times s^2} \]

where \( D_I \) is the C-W distance for the \( i \)th data set, \( r \) is the number of the replicates, \( \bar{Y}_I \) is the mean of the \( i \)th data set, \( \bar{Y} \) is the true value of the \( i \)th water quality parameter, \( p \) is the number of data set for \( i \)th parameter, \( s \) is the standard deviation of all observations of the \( i \)th parameter without outlier.

3) Each method was scored by comparing the corresponding C-W distance to a scoring system as follows:

<table>
<thead>
<tr>
<th>Score</th>
<th>C-W distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (Very Good)</td>
<td>0.00 to 2.00</td>
</tr>
<tr>
<td>4 (Good)</td>
<td>2.01 to 4.00</td>
</tr>
<tr>
<td>3 (Satisfactory)</td>
<td>4.01 to 4.99</td>
</tr>
<tr>
<td>2 (Questionable)</td>
<td>C-W distance between 5.00 and 10.00</td>
</tr>
<tr>
<td>1 (Poor)</td>
<td>C-W distance greater than 10.00</td>
</tr>
<tr>
<td>0 (Unacceptable)</td>
<td>With outlier(s)</td>
</tr>
</tbody>
</table>

Results and Discussion

Even though most county extension agents have no responsibility for chemical analysis, all attendees participated in the water quality sampling and analysis. The agents were guided in correct field and laboratory procedures and gained insight into the processes needed to conduct water quality sampling. Results obtained by each group were statistically analyzed and comparison was made and presented in this paper.

Six water samples were analyzed for pH with both pH meter and quick test kits (Fig. 6). Results from quick test kits were similar to measurements from the pH meter except for canal water. Coloration of canal water might affect the reading of pH strips. Quick test kits were not acceptable for electrical conductivity (EC) measurements (Fig. 7). EC values from quick test kits were about 100 times lower than measure-
ments from the EC meter. The EC meter was calibrated with standard EC solution and adjusted for temperature.

Nitrate in water samples were analyzed using quick test kits and an ion chromatograph (IC) (Fig. 8). Results of quick test kits were not even close to the analysis of IC except one sample. The concentration of nitrate for a groundwater sample collected next to our fertilizer storage building was 11.5 mg·kg\(^{-1}\) while quick test kits showed 0 mg·kg\(^{-1}\).

Phosphorus was analyzed using quick test kits, autoanalyzer and IC. Autoanalyzer method used in our laboratory is certified by NELAC. Figures 9 and 10 illustrate different results from these three methods. Quick test kits were not acceptable for analysis of water samples with low concentrations of phosphorus.

Quick test kits produced close results as AAS for potassium (K), but very poor results for copper (Cu) and iron (Fe) (Figs. 11-13). Results from quick test kits were also affected by the person using them (Fig. 14).

Various methods were ranked based on statistical analysis (Cook-Weisberg distance method) with known concentrations from Hoagland solutions (Table 4). Quick tests were ranked 5 for chloride, 4 for K and 0 for phosphate (PO\(_4\)).

Pre- and post-tests were given to participants. The knowledge increase was about 28%. The most important impact of the in-service training was the comments from participants. One of participants wrote... "Congratulations on an outstanding job of organizing the Extension Water Quality In-service training. This was one of the best I have attended..."
in recent years... demonstrated through the classroom lectures, field sampling, tour of pump station and Everglades National Park, airboat collecting trip, and finally the great water analysis lab sessions. Even some of us old hands learned new things.”

Table 4. Ranking various methods based on statistical analysis (Cook-Weisberg distance method) and known concentrations from Hoagland solutions.

<table>
<thead>
<tr>
<th>Methods</th>
<th>CI</th>
<th>NO$_3$N</th>
<th>PO$_4$P</th>
<th>K</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick test kits</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>IC</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Autoanalyzer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAS</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

*0 is unacceptable and 5 is very good.*
Literature Cited

