

# SAMPLE SIZE for Water Quality Measurements in Fish Ponds

CLAUDE E. BOYD and JOHN C. WILLIAMS\*

**D**ATA FROM ONE SAMPLE taken at a single station are generally used to portray the water quality of a pond, even though data to verify the effectiveness of this practice are unavailable. When multiple sampling is employed, the additional samples

are usually taken from different depths below a single station. This practice no doubt results because variation in water quality with depth has long been established, but there is little information on variation in water quality at a single depth at different stations. Therefore, the present research was conducted to obtain data on variation in water quality at different locations in ponds to serve as a guide in sampling pond waters.

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\*Professor, Department of Fisheries and Allied Aquacultures and Associate Professor, Research Data Analysis.

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AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY  
GALE A. BUCHANAN, DIRECTOR AUBURN UNIVERSITY, ALABAMA



## METHODS

Seven water quality variables were selected for study: dissolved oxygen, temperature, and Secchi disk visibility which were measured *in situ*, total hardness, filtrable orthophosphate, total particulate matter, and pH which were determined in the laboratory. These variables were selected partly because of their importance in fish culture, but the set also included variables expected to exhibit low, moderate, and high variation. Variables were also chosen because they could be measured rapidly. This shortened the time required for sampling and analysis, reducing variation in water quality because of natural diurnal fluctuations and changes during sample storage. Analytical procedures followed routines given by Boyd.<sup>1</sup>

Ponds were located on the Fisheries Research Unit, Auburn University Agricultural Experiment Station, Auburn University, Alabama. Fourteen fish ponds ranging from 0.1 to 25 acres in area and from 3 to 6 ft. in average depth were used. Each pond was sampled once between April 8 and June 9, 1977. Water samples were collected with a 90-cm water column sampler<sup>2</sup>, poured into 2-liter polyethylene bottles, and quickly transported to the laboratory for analysis. Dissolved oxygen, temperature, and Secchi disk visibility measurements were taken within a 3-foot radius of the location where each water sample was collected. Depending upon size, 6 to 24 samples and *in situ* measurements were obtained per pond. The sampling stations were randomly located in each pond. Sampling was initiated between 8 and 10 a.m. and completed within 15 to 45 minutes.

## RESULTS AND DISCUSSION

Means and variances were calculated for data from each pond. However, since pond

size had no influence on the magnitude of the variances, variances were pooled from all ponds to obtain a mean variance for each variable. The mean variance values and the ranges of means of variables for the 14 ponds are presented in table 1. All ponds had relatively low total hardness concentrations. However, means for the other variables covered the ranges generally expected during the growing season in most fish ponds in Alabama.

The mean variance values, table 1, were used in the following equation<sup>3</sup> to calculate sample sizes:

$$n = \frac{4s^2}{L^2},$$

where: n = sample size (number of samples); s<sup>2</sup> = variance; L = allowable error (95 percent probability level). Sample sizes for selected allowable errors are presented in table 2. The mean variance and the equation given above may be used to calculate sample size for any other desired allowable error. Once the decision on sample size is made, the samples must be collected from randomly located sites in the pond.

The requirement for samples was least for pH, temperature, and total hardness, intermediate for dissolved oxygen and filtrable orthophosphate, and greatest for Secchi disk visibility and total particulate matter, table 2. The large variability in Secchi disk visibility and total particulate matter reflects the influence of phytoplankton on these measurements. Phytoplankton forms scums on pond surfaces which drift in response to wind action and form greater accumulations at some locations on pond surfaces than at others.

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<sup>1</sup>BOYD, C. E. 1979. Water Quality in Warm-water Fish Ponds. Auburn University (Ala.) Agricultural Experiment Sta. 359 p.

<sup>2</sup>BOYD, C. E. 1973. Summer Algal Communities and Primary Productivity in Fish Ponds. *Hydrobiologia* 41: pp. 357-390.

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<sup>3</sup>SNEDECOR, G. W. 1956. Statistical Methods. The Iowa State University Press, Ames, Iowa. 534 p.

TABLE 1. RANGE OF MEANS FOR WATER QUALITY MEASUREMENTS ON SAMPLES FROM 14 FISH PONDS AND MEANS OF VARIANCES FOR DATA FROM ALL PONDS

| Variable  | Range of means | Mean variance |
|---|----------------|---------------|
| Dissolved oxygen (mg/liter) . . . . .                     | 7.3 - 15.1     | 0.37          |
| Secchi disk visibility (cm) . . . . .                     | 23 - 143       | 40.83         |
| Temperature (°C) . . . . .                                | 20.4 - 27.3    | 0.072         |
| pH . . . . .  | 6.4 - 9.6      | 0.034         |
| Total hardness (mg/liter as CaCO <sub>3</sub> ) . . . . . | 8.1 - 27.0     | 0.11          |
| Particulate organic matter (mg/liter) . . . . .           | 3.8 - 53.3     | 14.02         |
| Filtrable orthophosphate (µg/liter) . . . . .             | 2 - 96         | 17.25         |

TABLE 2. NUMBERS OF WATER SAMPLES REQUIRED FROM PONDS TO ESTIMATE THE MEANS OF WATER QUALITY VARIABLES WITH A 95 PERCENT CERTAINTY THAT ERRORS WILL NOT EXCEED THE SPECIFIED AMOUNTS

| Variable                  | No. | Variable                  | No. |
|---------------------------|-----|---------------------------|-----|
| Dissolved oxygen          |     | Total hardness            |     |
| ± 0.5 mg/liter . . . . .  | 6   | ± 1.0 mg/liter* . . . . . | 1   |
| ± 1.0 mg/liter* . . . . . | 2   |                           |     |
| pH                        |     | Total particulate matter  |     |
| ± 0.25 unit . . . . .     | 2   | ± 1 mg/liter . . . . .    | 54  |
| ± 0.5 unit* . . . . .     | 1   | ± 2 mg/liter* . . . . .   | 14  |
| ± 1.0 unit . . . . .      | 1   | ± 5 mg/liter . . . . .    | 3   |
| Secchi disk visibility    |     | Filtrable orthophosphate  |     |
| ± 2 cm . . . . .          | 40  | ± 1 µg/liter . . . . .    | 69  |
| ± 5 cm* . . . . .         | 7   | ± 5 µg/liter* . . . . .   | 3   |
| ± 10 cm . . . . .         | 2   | ± 10 µg/liter . . . . .   | 1   |
| Temperature               |     |                           |     |
| ± 0.5° C . . . . .        | 2   |                           |     |
| ± 1.0° C* . . . . .       | 1   |                           |     |

\*Sufficiently reliable for routine purposes.

*Information contained herein is available to all without regard to race, color, sex, or national origin.*