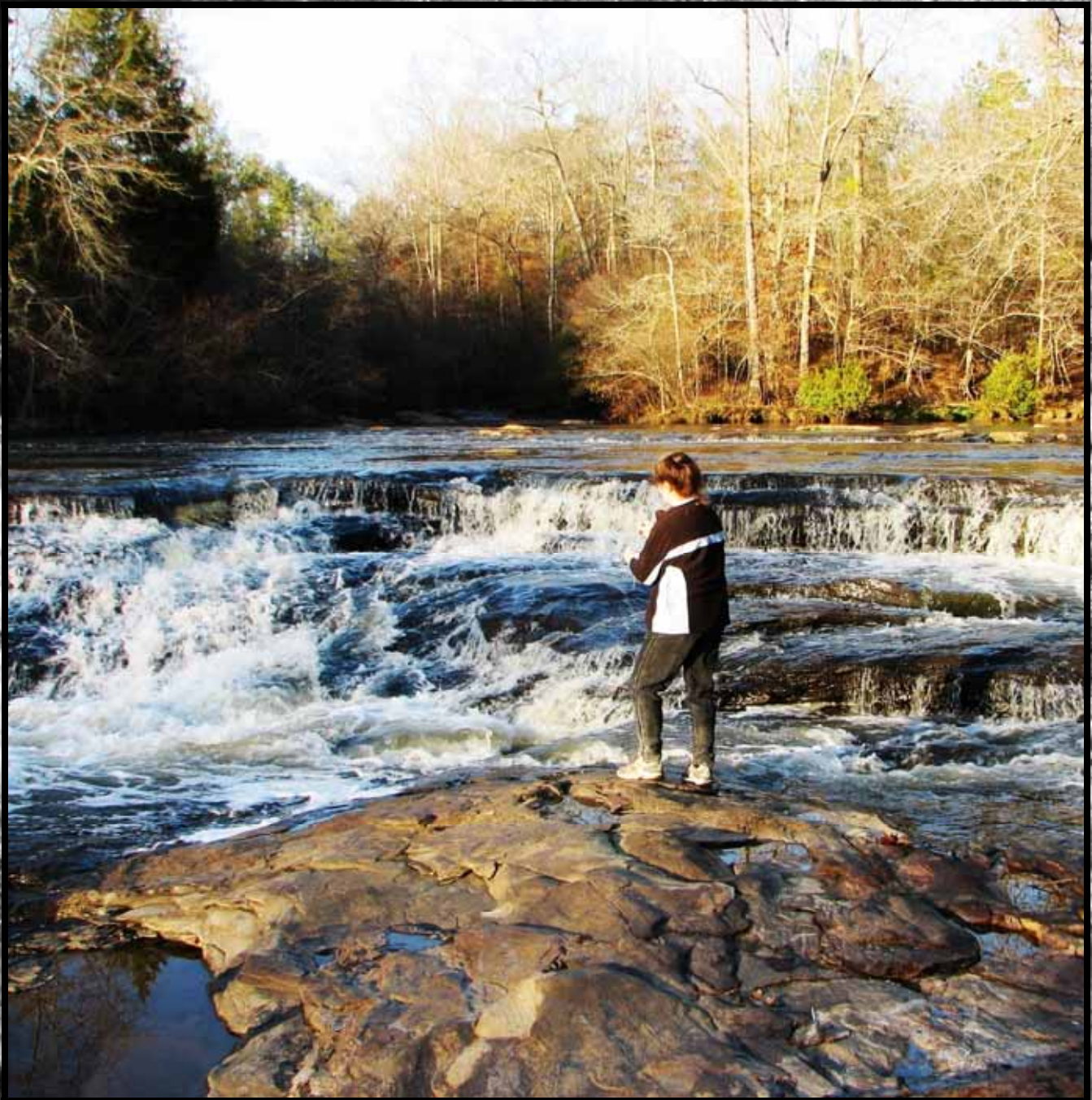


Community-Based Water Quality Monitoring
Data Credibility and Applications

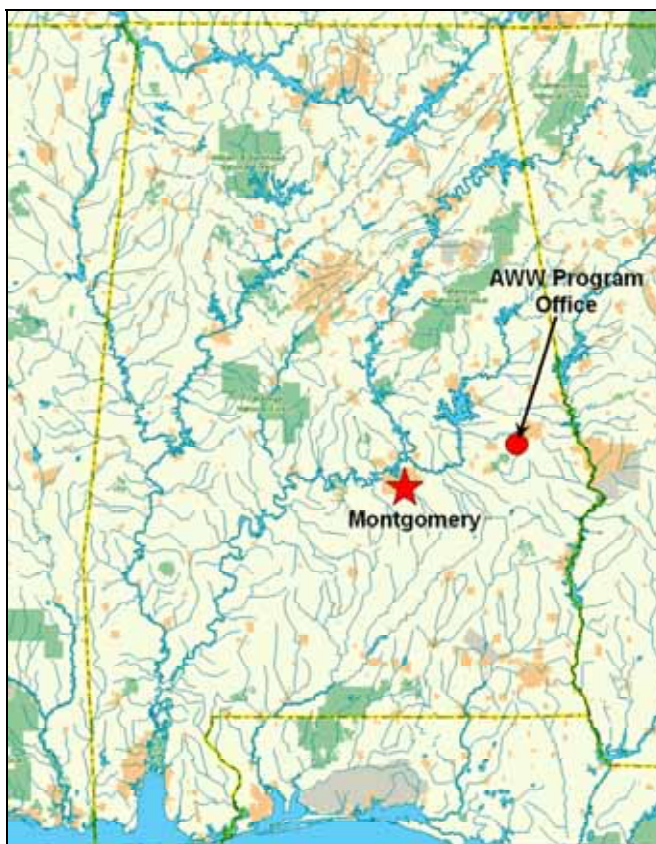


Background of the Alabama Water Watch Program

Alabama Water Watch (AWW) is a citizen volunteer, water quality monitoring program that began in 1992. The Program is coordinated from the Auburn University Fisheries Department, with primary funding from the Alabama Department of Environmental Management (ADEM, the state's environmental regulatory agency) and the U.S. Environmental Protection Agency (EPA), Region IV. The Program grew out of a strong grassroots movement of local groups that had formed for the protection of waterbodies throughout the state. Many citizens feel it is their right and responsibility to become actively involved in protecting and restoring Alabama's water resources. These groups realize that advocacy for local waters requires strong community-based knowledge and action. Since its inception, AWW has developed strong relationships with water-based groups and worked with them to enhance their capabilities in watershed stewardship.

The mission of AWW is to improve both water quality and policy through citizen monitoring and action. Citizen volunteers attend one or more AWW workshops to become certified monitors of water quality. In the workshops, participants learn simple techniques for measuring various chemical, physical and biological characteristics of water, such as water temperature, dissolved oxygen (DO), alkalinity, hardness, turbidity, pH and bacterial concentrations.

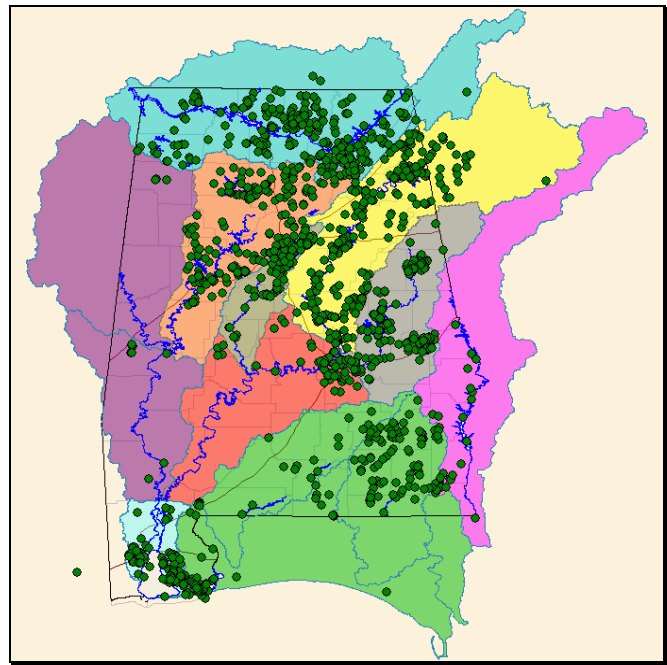
AWW's vision is to have a citizen monitor on every stream, river, lake, and bay in Alabama. This is a lofty goal since Alabama is such a water-rich state. There are over 75,000 miles of streams and rivers and 490,000 acres of lakes in the state. The state's rivers and stream convey about 8% of the surface water that flows through the continental United States.



Alabama, a water-rich state.

Alabama's surface waters cut through a wide variety of landscapes, including Appalachian valleys and ridges, prairie soils of the Black Belt, sandy soils of the Coastal Plain and other physiographic provinces. All this physical diversity in soil types, topography, geology and vegetative land cover leads to an impressive diversity of aquatic life. More than 700 species of fish, mussels, snails, and crawfish live in Alabama's rivers and streams, which ranks it as the number one state in abundance of these aquatic species. Some of these organisms are endemic, meaning that they occur only in Alabama.

Since AWW began, more than 240 citizen groups have participated, cumulatively sampling more than 1,900 sites on about 700 waterbodies and submitting more than 52,000 water quality data records to the AWW database. The Program has certified about 4,700 citizen monitors, who have monitored over 1,950 sites on 700 waterbodies in Alabama, Georgia, Florida and Tennessee. Several groups have submitted water data for more than 10 years. For many waterbodies in Alabama, citizen data is the primary or only source of water quality information available. Citizen water quality data can be explored at the AWW website, www.alabamawaterwatch.org.



AWW citizen volunteer monitor sites.

GWW – Extending AWW Community-Based Water Monitoring around the Globe

Global Water Watch (GWW) is a voluntary network of community based water monitoring groups. AWW staff have traveled to six other countries, the Philippines, Brazil, Mexico, Ecuador, China and Thailand, to train people in water monitoring techniques, water data management and applications, and action strategies in watershed management. The overall goal of GWW is to foster the development of citizen volunteers to monitor surface waters for the improvement of both water quality and public health. GWW helps communities establish teams of citizens who measure physical, chemical and biological indicators of watershed health. Monitors use their data to manage watersheds for the restoration of streams and lakes, improvement of drinking water and public health, and implementation of environmental education programs for the public.



GWW participants learn how to monitor water chemistry (left) and total suspended solids (right) in the Philippines. The GWW Program began in Lantapan Province, Mindanao in 1994 as part of a 10-year USAID Sustainable Agriculture & Natural Resources Management (SANREM) project.

GWW was initially modeled on the AWW Program and experiences. In recent years, learning about community-based monitoring has become a two-way street, with the development of international partnerships between citizen groups for the sharing of information. To learn more about GWW partners and to explore their data online, go to www.globalwaterwatch.org.

Establishing Credible Citizen Data

AWW developed quality assurance (QA) plans for water monitoring, and submitted them to EPA. EPA approved the AWW water chemistry monitoring QA plan in 1994 and a revision of it in 2004, and the bacteriological monitoring QA plan in 1999. These plans outline the procedures and requirements of the AWW Program in training and certifying volunteer monitors, maintenance of accurate sampling equipment, and data management to ensure quality data.

WATER CHEMISTRY QUALITY ASSURANCE PLAN
(Revision of the Quality Assurance Plan Approved June, 1994)

For



**Alabama
Water
Watch**

A Program dedicated to developing
Citizen Volunteer Monitoring of
Alabama's Lakes, Streams and Coasts
Funded in part by a grant from the U.S. EPA, Region 4
Clean Water Act, Section 319
And the Alabama Department of Environmental Management

Prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 4
January 23, 2004

APPROVALS

<u>Ronald E. Estridge</u>	<u>1/23/04</u>
Ronald E. Estridge, M.S., Data Quality Coordinator	Date
<u>William G. Deutsch</u>	<u>1/23/04</u>
William G. Deutsch, Ph.D., AWW Program Manager	Date
<u>Norman Blakey</u>	<u>1/26/04</u>
Norman Blakey, ADEM Project Director	Date
<u>Marilyn Thornton</u>	<u>March 9, 2004</u>
Marilyn Thornton, U.S. EPA Region 4, Quality Assurance Manager	Date

QUALITY ASSURANCE PLAN FOR BACTERIOLOGICAL MONITORING
(Addendum to the Quality Assurance Plan approved on March, 1995)

for



**Alabama
Water
Watch**

A Program dedicated to developing
Citizen Volunteer Monitoring of
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Funded in part by a grant from the U.S. EPA, Region 4
Clean Water Act, Section 319
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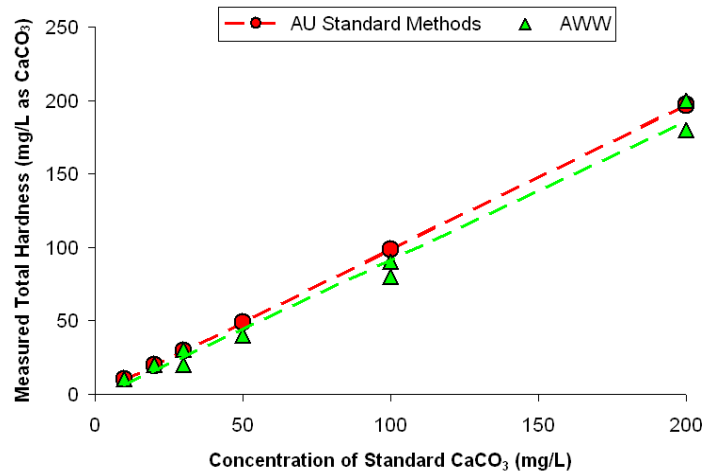
prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4, Section 319
November 10, 1999

APPROVALS:

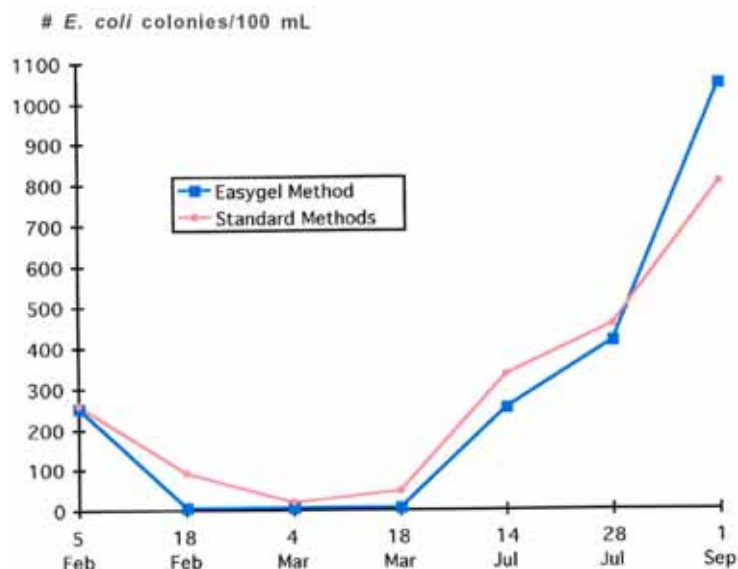
<u>Allison E. Busby</u>	<u>11/16/99</u>
Allison E. Busby, M.S., AWW QA/QC Officer	Date
<u>William G. Deutsch</u>	<u>11/16/99</u>
William G. Deutsch, Ph.D., AWW Program Manager	Date
<u>Norman Blakey</u>	<u>12/3/99</u>
Norman Blakey, ADEM Project Director	Date
<u>Gary Bennett</u>	<u>12-20-99</u>
Gary Bennett, U.S. EPA Region 4, Quality Assurance Officer	Date

AWW quality assurance (QA) plans for water chemistry and bacteriological monitoring submitted to EPA, and approved in 1994 (original water chemistry QA plan), 1999 (bacteria QA plan), and 2004 (revised water chemistry QA plan). Plans are available digitally at www.alabamawaterwatch.org.

As part of the QA plans, side-by-side testing of the AWW water chemistry and bacteriological tests were conducted over a wide range of concentrations to determine precision and accuracy compared to Standard Methods (APHA 1998) used by professional scientists in university, state and federal water quality laboratories. Correlations between the AWW test results and those of Standard Methods were comparable (graphs below), and this and other information led to EPA approval of AWW water chemistry and bacteriological monitoring protocols. AWW was one of the first citizen monitoring programs in the U.S. to receive EPA endorsement for bacteriological monitoring for the fecal bacterium *Escherichia coli* (*E. coli*) and other coliform bacteria.

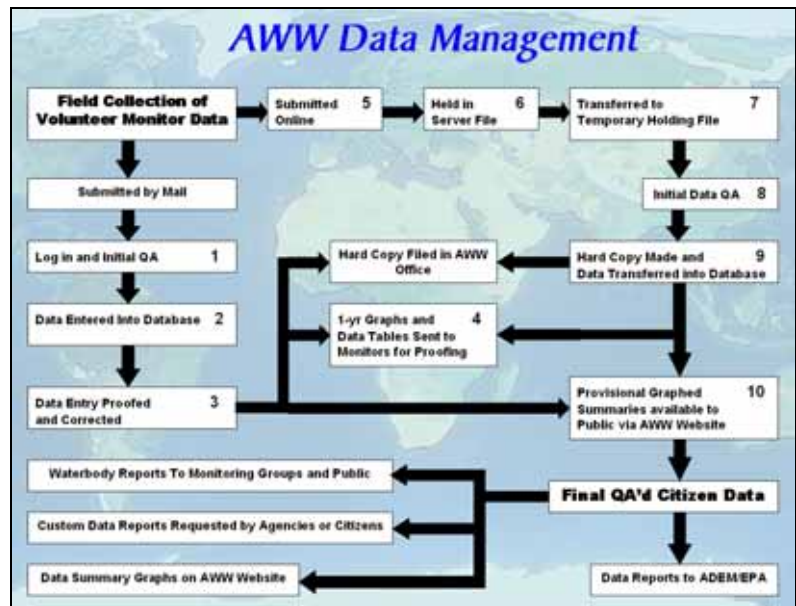


Results of hardness testing of samples ranging from 10-200 mg/L measured by Auburn University (AU) Standard Methods and the AWW test kit (Allison Busby and Eric Reutebuch conduct side-by-side tests, pictured above).



Results of *E. coli* sampling over a wide range of concentrations (0-1,100 colonies/100 mL) measured by AU Standard Methods and the AWW Easygel Coliscan Method. Side-by-side testing was conducted on seven dates from 5/2/1999-9/1/1999. When read after about 30 hours of incubation according to the AWW bacteriological monitoring protocol, *E. coli* colonies appear blue-to-purple and other coliform bacteria appear pink-to-red on the Easygel Coliscan plates (Dr. Cliff Webber tallies bacteriological monitoring results, pictured above).

An integral part of quality assurance are refresher courses to maintain proper sampling techniques and replenish monitor test kits with fresh chemical reagents. The Program offers refresher courses for water chemistry and bacteriological monitoring at two levels – citizen monitor refresher courses, and trainer refresher courses. Program staff recognized early-on that training citizen monitors throughout the state would be a daunting task, so materials were developed for the training of trainers. To date, more than 1,100 workshops have been conducted, and last year (excluding the Training-of-Trainer Workshops) 80% of training sessions were conducted by or with citizen trainers.

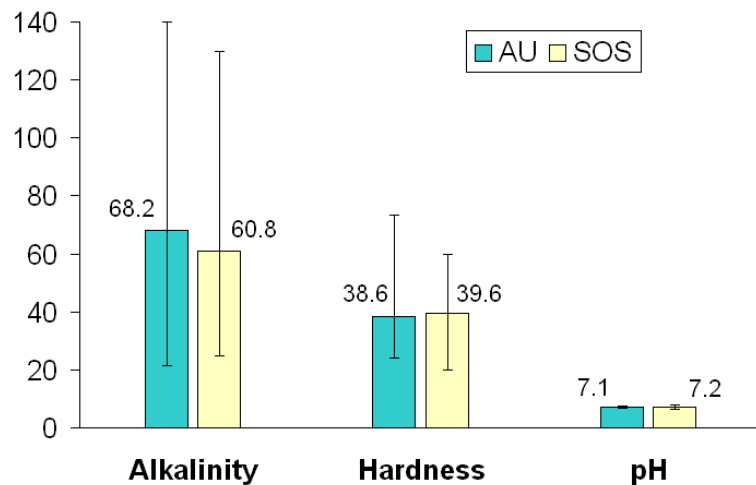


Bill Deutsch, AWW Program Manager, recertifying citizen volunteer monitors of the Smith Lake Environmental Preservation Committee and Smith Lake Civic Association at Deb and Bob Berry's home on Smith Lake (above left). AWW processes citizen water data through a sequence of multiple steps of quality assurance before publishing it in reports, posting it on the web, or reporting the data to ADEM (above right).

The credibility of citizen data has been verified repeatedly at different levels, and at various locations throughout the state. Micro-level verification involves the training and certification/recertification of volunteer monitors in AWW testing procedures, and laboratory and field side-by-side testing. Macro-level verification involves comparison of citizen and professional data at a watershed scale. Following are several examples of AWW citizen data verification at both the micro- and macro- levels.

Over the past 15 years of AWW citizen monitoring, there have been several opportunities to compare citizen water quality data to that of professional agencies which follow Standard Methods monitoring protocols. Rarely are the data taken in exactly the same location at exactly the same time, or even on the same date. None-the-less, professional-versus-citizen data comparisons yield remarkably similar results, that are certainly within the criteria of resource managers for use in watershed management.

A comparison of data from Auburn University (AU) researchers and Save Our Saugahatchee (SOS) citizen volunteer monitors was analyzed for data comparability and quality (graph below). SOS volunteer monitors had received training and certification from AWW in water chemistry monitoring. Measurements were taken monthly from February, 2005 through January 2007, a total of 24 monthly measurements at SOS site 07011007, Saugahatchee Creek at Lee County Road 188 Bridge, just north of Loachapoka, Alabama. The averages for alkalinity, hardness and pH measured by SOS volunteer monitors did not differ statistically from those of professional (AU) researchers, even though measurements were not made on the same date each month. Also, both volunteer and professional data showed significantly higher alkalinity compared to hardness. The reason for this anomaly was caused by the inflow of textile effluent into Saugahatchee Creek upstream of the sample site. High alkalinity measurements (in the absence of high hardness) have correlated with amounts of textile effluent, and have been considered by SOS as a surrogate measure of industrial waste load in the creek.

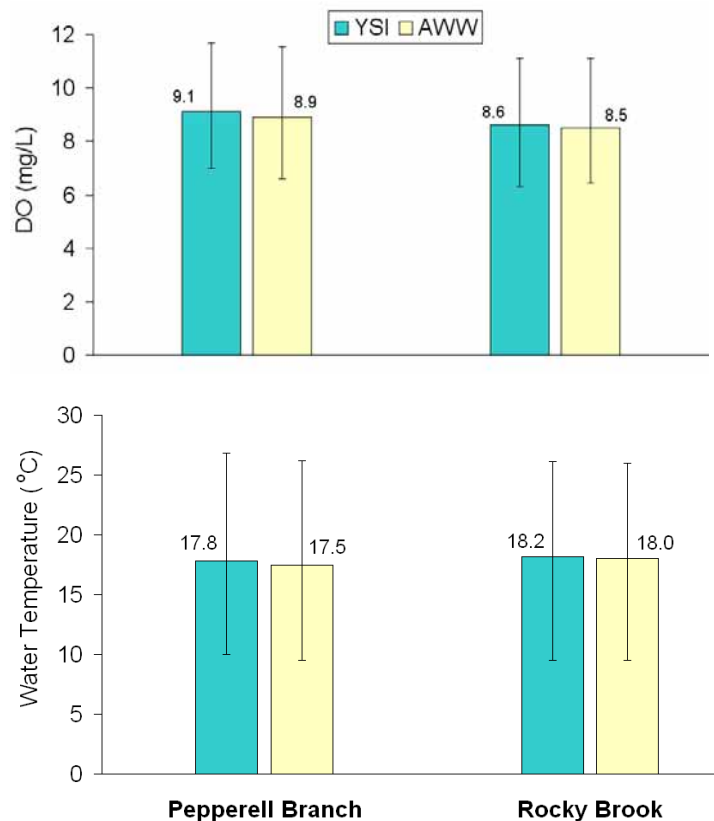


Average alkalinity, hardness and pH measured by AU researchers (turquoise bars) and SOS volunteer monitors (yellow bars) at Lee County Road 188 Bridge near Loachapoka, Alabama. Measurements were taken monthly for 24 months from 2/2005-1/2007. Vertical lines on bars represent range of values (minimum and maximum). SOS monitors Tom Ivers and Todd Miller (above) sample the creek at this site.

A year-long study was initiated in January of 2006 to evaluate the accuracy and precision of the AWW dissolved oxygen (DO) test against the YSI dissolved oxygen meter in side-by-side testing. The study was conducted on two streams, Pepperell Branch and Rocky Brook, which flow through the city of Opelika in east-central Alabama.



The DO measurement is a very important water quality parameter because concentrations below 5 parts per million (ppm) stress fish and may result in reduced aquatic biodiversity, since fish and most other aquatic creatures depend on oxygen from water. ADEM regulations require a DO level of at least 5 ppm (unless low DO occurs from natural causes) in waters that are classified as “Fish and Wildlife”. Results of the year-long study (graphs at right) show

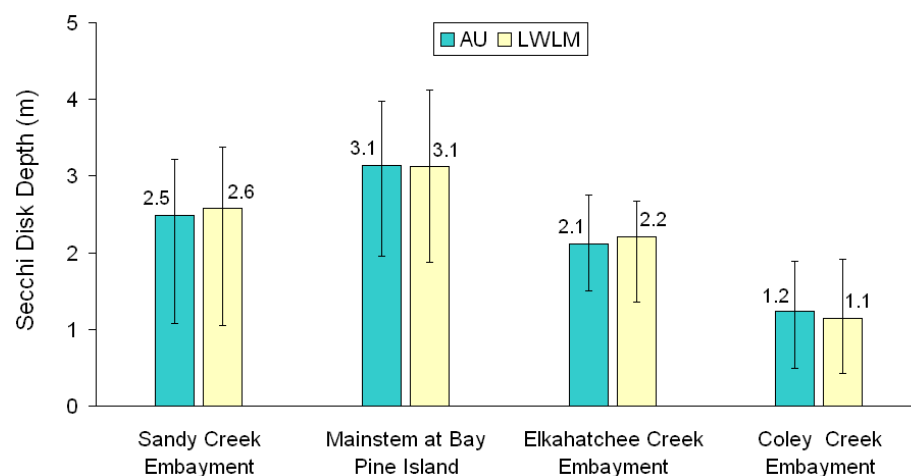


Average DO (top graph) and water temperature (bottom graph) measured with a YSI meter (turquoise bars) and the AWW test kit (yellow bars) at two streams, Pepperell Branch and Rocky Brook, in Opelika, Alabama. Measurements were taken monthly for 12 months from 1/2006-1/2007. Vertical lines on bars represent range of values (minimum and maximum).

that the AWW test kit yielded an accurate measure of DO as well as water temperature (there were no significant differences between the AWW results and those of the YSI meter). The average of DO measurements using the AWW test kit differed less than 0.2 ppm from those of the YSI meter at each site. AWW water temperature measurements differed less than 0.3 °C from those of the YSI meter.

A three-year research project known as the Tallapoosa Watershed Project (TWP, funded by a USDA-CSREES grant) provided an excellent opportunity to conduct additional professional-versus-AWW side-by-side testing, since it engaged both AU researchers and AWW citizen volunteer monitors in lake water quality monitoring. An important objective of the TWP was to verify citizen volunteer monitor data and strengthen citizen monitor capabilities in measuring lake water quality and eutrophication (for more information, go to www.twp.auburn.edu).

Lake eutrophication is expressed as trophic state index (TSI), which equates the range of oligotrophic (very clean, nutrient-poor lakes with low algae biomass) to eutrophic (polluted, nutrient-rich lakes with high algae biomass) to a range of numeric values from 0 to 100 (Carlson 1977). TSI values are used by state agencies such as ADEM to communicate the condition or ‘health’ of a lake to the public. The TSI of a lake can be determined by analyzing the chlorophyll or total phosphorus concentration of a water sample in the laboratory, both of which are fairly complex analyses. A third way to calculate TSI is from Secchi disk depth, which is a measurement that many volunteer monitors routinely record at lake monitoring sites. Secchi disk depth is simply the depth at which a Secchi disk, when lowered into a lake, disappears, and represents a measure of lake water clarity. One important caveat in using Secchi disk depth to determine lake TSI is that it only works when decreased water clarity is from suspended algae (indicative of green water) and not from suspended soil or clay particles (indicative of brown or red-brown, muddy water). The graph below compares growing season (April-October) averages of Secchi disk measurements taken by TWP researchers to those of Lake Watch of Lake Martin (LWLM) volunteer monitors at four sites on Lake Martin, near Alexander City, Alabama.

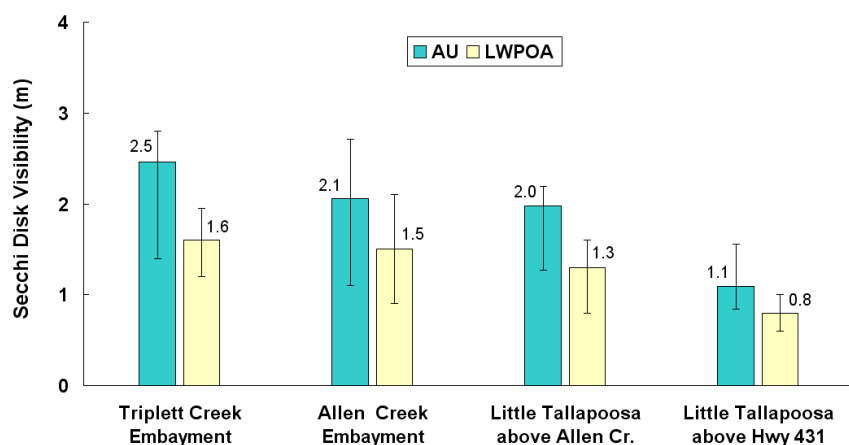


Average Secchi disk depth measured by AU researchers (turquoise bars) and LWLM citizen volunteer monitors (yellow bars) at four sites on Lake Martin near Alexander City, Alabama. Measurements were taken monthly for seven months from 4/2004-10/2004. Vertical lines on bars represent range of values (minimum and maximum). LWLM monitor and President, Dick Bronson (above) uses an AquaScope to measure Secchi depth at his monitoring site on Lake Martin.

Results indicate that there were no significant differences between Secchi measurements of LWLM citizen monitors and those of professional researchers (site averages of AU versus LWLM were within 0.07 meters of each other across the four sites). At all four sites, both professional and citizen data

indicated the same lake trophic state - mesotrophic (Secchi depth of between 2-4 meters) at two embayment and one mainstem site, and eutrophic (Secchi depth of less than 2 meters) at a third embayment site (Coley Creek Embayment, which receives municipal waste water treatment plant effluent). LWLM monitors employed the AquaScope II to cut surface glare while taking Secchi measurements, similar to the device used by AU researchers.

During the second year of the TWP, sampling efforts moved up the Tallapoosa Basin to Lake Wedowee. Another growing season of data was collected during which AU researchers sampled side-by-side with citizen monitors of the Lake Wedowee Property Owners Association (LWPOA) at four sites on the lake. The Secchi dataset (graph below) did not show as close an agreement between citizen and professional measurements as the 2004 Lake Martin dataset. Significant differences between the AU and LWPOA Secchi measurements were attributed to technique – LWPOA monitors did not use a ‘AquaScope’ viewing device while taking Secchi depth readings.

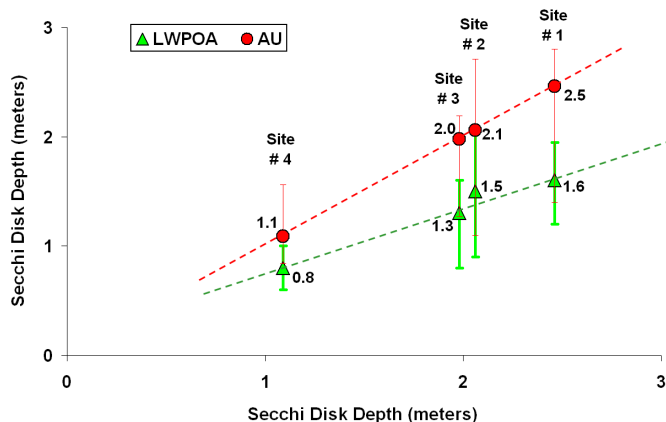


Average Secchi disk depth measured by AU researchers (turquoise bars) and LWPOA citizen volunteer monitors (yellow bars) at four sites on Lake Wedowee near Wedowee, Alabama. Measurements were taken monthly for seven months from 4/2005-10/2005. Vertical lines on bars represent range of values (minimum and maximum). LWPOA monitor and President, Charles Smith (above) measures Secchi depth at his monitoring site on Lake Wedowee.

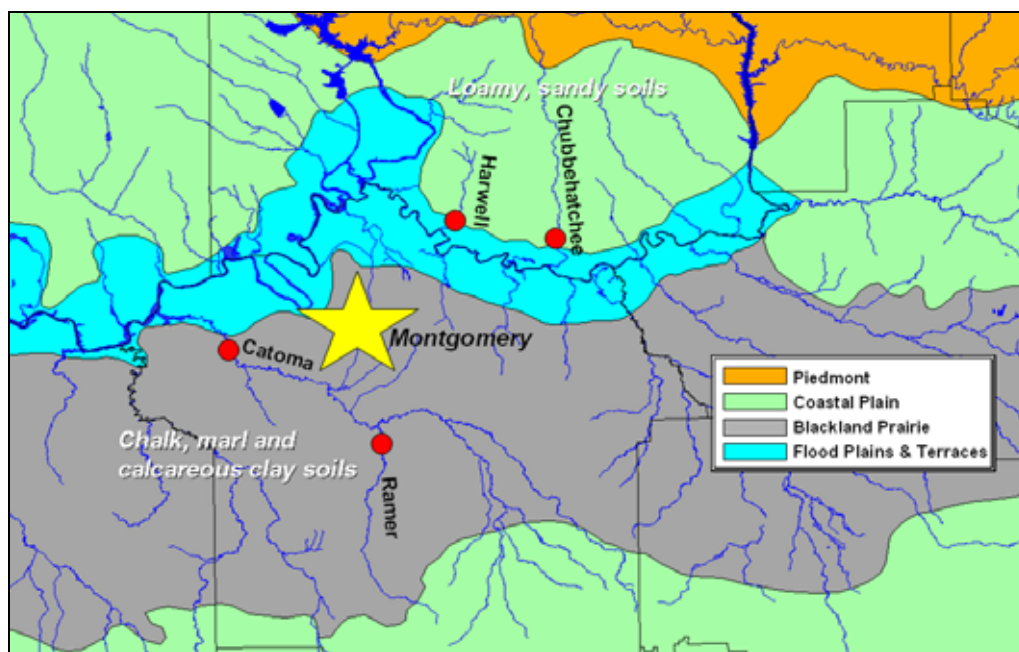
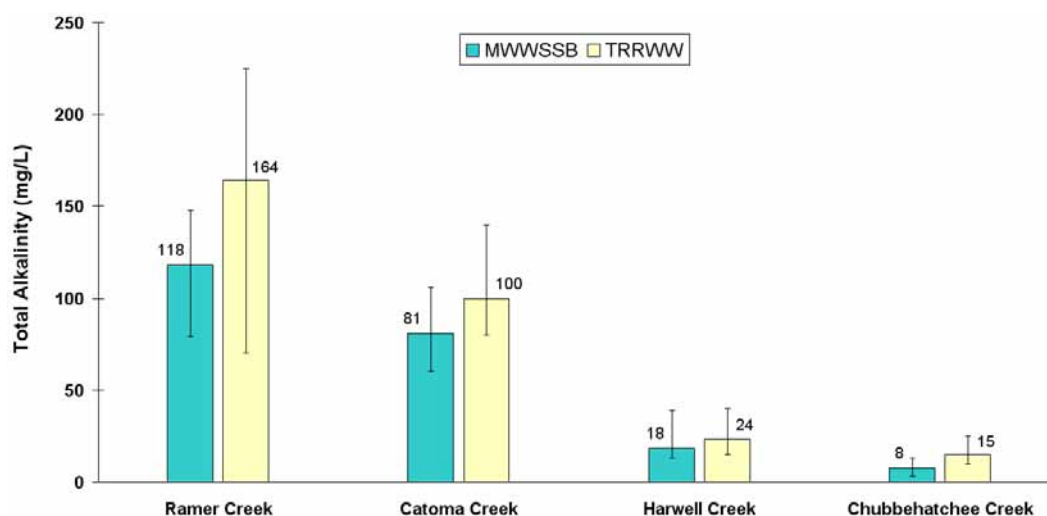
Differences between Secchi measurements of LWPOA monitors and those of AU researchers indicated that not only were there significant differences in Secchi measurements with-and-without the use of an ‘AquaScope’ device, but that the differences became larger as water clarity increased. Quantification of these differences (graph below) provides a method for ‘correcting’ Secchi readings taken without a view scope so that they are comparable to *Standard Methods* Secchi readings via the equation:

$$\text{Standard Methods Secchi (with scope)} = [(\text{Citizen Secchi without scope}) - 0.154] / 0.604$$

Differences in Secchi disk depth measured by Auburn University (AU, red line) researchers and Lake Wedowee Property Owners Association citizen volunteer monitors (LWPOA, green line) at four sites on Lake Wedowee near Wedowee, Alabama. AU researchers used a ‘view-scope’ device similar to the AquaScope, and LWPOA citizen monitors did not. Measurements were taken monthly for seven months from 4/2005-10/2005. Vertical lines on bars represent range of values (minimum and maximum readings).



Examination of stream data across different physiographic provinces can reveal variations in water quality based on natural causes such as soil type and mineral content. Comparison of professional data collected in the vicinity of Montgomery, Alabama by professionals of the Montgomery Water Works and Sanitary Sewer Board (MWWSSB) with data collected by citizen monitors of the Tri-River Region Water Watch (TRRW) reveals such naturally-occurring differences (graph and map below). Although monitoring was not coordinated by date or exact sample site location, both datasets show a stepwise gradient in alkalinity from high (above 100 mg/L) for streams draining calcareous Blackland Prairie or Black Belt soils to low (less than 20 mg/L) for streams draining sandy Coastal Plain soils that typically lack calcium content. Knowledge of the range in water quality parameters of unpolluted, natural waters is required before watershed managers can determine if a stream or lake is being adversely impacted by point or nonpoint sources of pollution.



Average alkalinity measured by Montgomery Water Works and Sanitary Sewer Board (MWWSSB) and Tri-River Region Water Watch (TRRW) citizen volunteer monitors at four streams near Montgomery, Alabama. Data include 125 records measured by TRRW monitors and 134 records measured by MWWSSB staff from 1999-2002. Values above bars represent averages, and vertical lines on bars represent range of values (minimum and maximum).

Applications of Citizen Water Quality Data

Citizen water data have been used for many informal and formal purposes in Alabama and in other countries. Informal uses have included 1) content for data interpretation presentations and waterbody publications by AWW staff, 2) mapping and sourcing of bacterial levels, 3) determining if the water quality of a waterbody is getting better or worse, 4) determining the relative health of a watershed, 5) monitoring drinking water supplies for bacterial contamination, and 6) environmental education in collaboration with schools. Formal uses have included 1) presentations at professional conferences, 2) influencing water policy, 3) upgrading of waterbody use classification, 4) development of watershed management plans, 5) inclusion in the ADEM Water Quality Report to Congress, and 6) using in the process of delisting of 303(d)-listed streams.



AWW has available more than a dozen waterbody reports in which citizen groups work with AWW staff in presenting water facts and figures, changes in watershed land use, local environmental issues, the group's water quality data trends from sites that they monitor, and their action strategies for protecting their local waterbodies.

There have been many informal uses of citizen data over the past 15 years, the following are some examples.

Annual State of the Lake Address

In October 2006, a large group of Smith Lake residents - members of the Smith Lake Environmental Preservation Committee (SLEPC), gathered at Bethany Baptist Church in Cullman County for the *10th Annual State of the Lake Address*. AWW Program staff have presented interpretation of lake water quality data made evident through examination of monthly data records that Smith Lake citizen monitors have accumulated since monitoring began in 1996. SLEPC holds the annual event to educate lake residents about a variety of water quality issues, methods and tools to monitor lake water quality, and action strategies for protecting their lake.



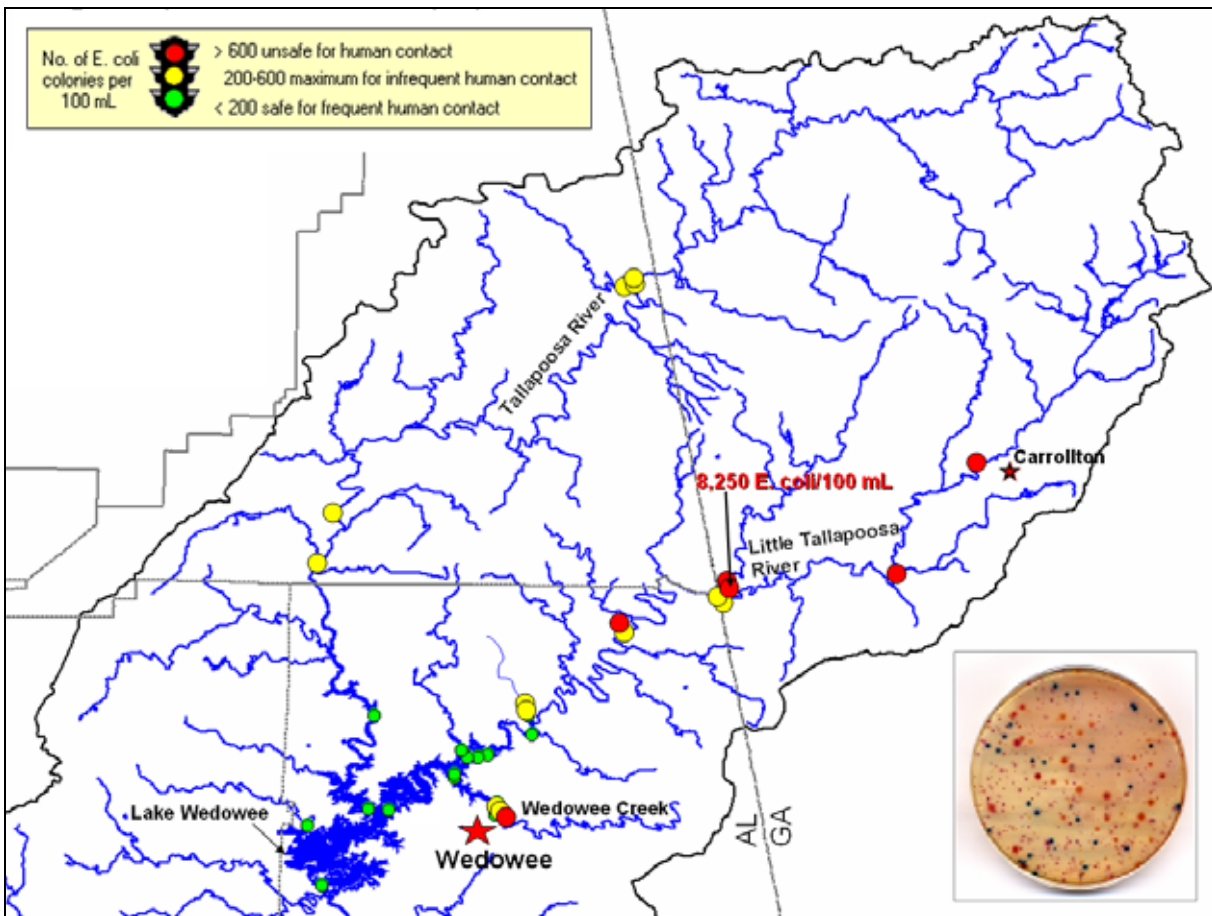
Bill Deutsch, AWW Program Manager, discussing water quality trends revealed by Logan Martin Lake Protection Association citizen data in Pell City, AL in February 2006.



Eric Reutebuch, AWW Publications Coordinator, discussing AWW web-based tools to members of the Smith Lake Environmental Preservation Committee in Bremen, AL in November 2005.

Watershed-level Bacteria Monitoring

Citizen monitors of the Lake Wedowee Property Owners Association (LWPOA) have been monitoring the waters of Lake Wedowee in Randolph County, Alabama since 1998. Spurred by a growing concern about bacterial contamination of the lake from septic systems, waste water treatment facilities, campgrounds, and nonpoint source runoff from poultry and cattle rearing operations, six LWPOA monitors received training and certification in bacteriological monitoring from AWW in March 2006. The group drafted a bacteriological sampling plan to test for levels of *E. coli* at 22 sites throughout the Lake Wedowee Watershed (see map below). At the completion of their *Upper Tallapoosa Watershed Bacteria Study*, LWPOA citizen monitors had taken about 100 samples, in triplicate according to the AWW protocol, throughout the growing season (April-October). Results indicated that 1) the highest *E. coli* levels (up to 8,250 colonies/100 mL of water) occurred in the Little Tallapoosa River just upstream of the Alabama-Georgia state line, 2) high levels of *E. coli* were also measured in Wedowee Creek (up to 2,786 colonies/100 mL of water) and in the Tallapoosa River (up to 506 colonies/100 mL of water), 3) the sources appeared to be from nonpoint source runoff because high levels of *E. coli* were detected following rainfall/runoff events, and 4) *E. coli* were not measured in the main body of Lake Wedowee, only in its tributary rivers and streams. Armed with this wealth of information, LWPOA citizen monitors plan to determine the sources of *E. coli* in tributaries entering the lake, and work on solutions to eliminate bacteria contamination in the watershed.



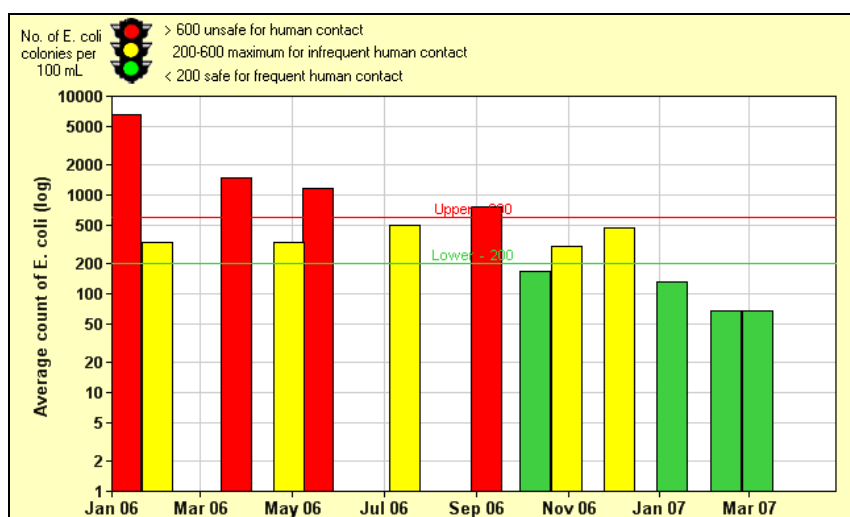
Map showing sites in the Lake Wedowee Watershed that had harmful levels of *E. coli* (sites in red had > 600 colonies/100 mL of water, sites in yellow had 200-600 colonies/100 mL, sites in green had < 200 colonies/100mL) during the 2006 growing season.

Bacteriological monitoring has proven to be a valuable watershed management tool in other countries. GWW-Veracruz citizen monitors are using the AWW protocol and Easygel Coliscan plates to monitor for *E. coli* levels in rivers and streams in the state of Veracruz, Mexico.

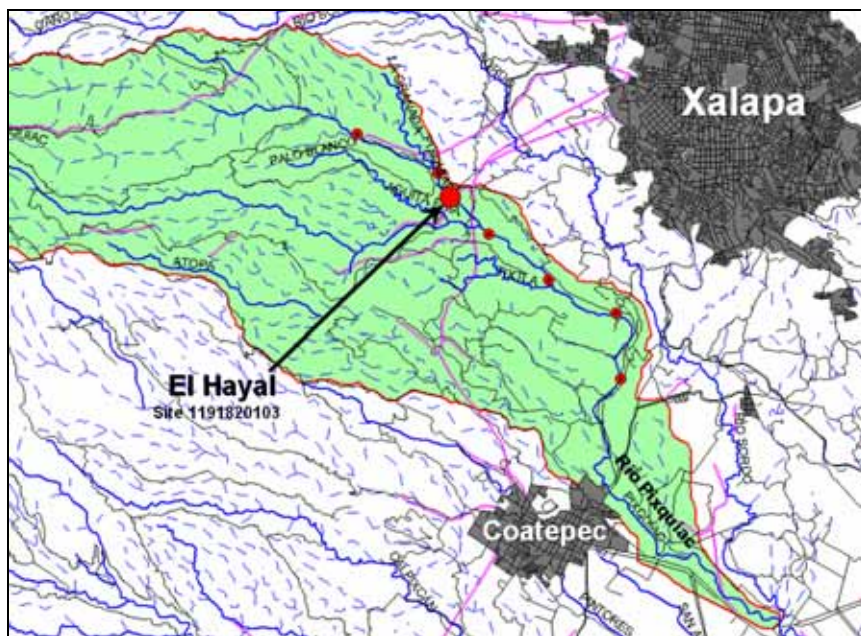


Bill Deutsch, AWW Program manager, and Sergio Ruiz-Córdova, AWW Database Specialist, discuss results of a watershed-level assessment of *E. coli* that they conducted with GWW-Veracruz monitors in 2006 (top left). After receiving training and certification as water quality trainers, GWW-Veracruz has conducted 24 trainings in water quality monitoring and trained more than 100 citizen monitors (March 2007 training pictured, top right).

Certified monitors began measuring bacteria levels, water chemistry and discharge at seven sites on the Rio Pixquiac, south of the city of Xalapa in Veracruz in January 2006 (see map and graph below). They measured high levels of *E. coli* (6,467 colonies/100 mL of water) at the El Hayal site during the first month of sampling. They then conducted a stream walk upstream to search for the source of *E. coli*. They discovered a pig farm upstream where the animals had free access to the river. The GWW monitors were able to convince the farmer to reduce the pigs' access to the river. By the end of the year, levels of *E. coli* had decreased dramatically, to safe levels, well below the 200 colonies/100 mL of water. The group has greatly expanded water monitoring in the state of Veracruz, and into other states in Mexico. Several GWW-Veracruz monitors have been certified as trainers by the AWW Program, and have conducted 24 workshops in water chemistry and bacteriological monitoring to train and certify other citizen monitors in the region.



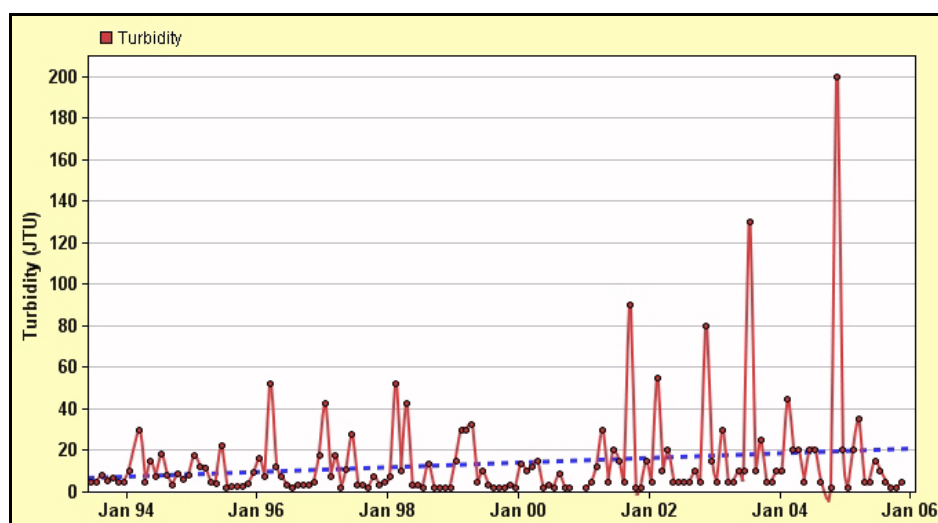
Fifteen month trend in *E. coli* levels measured by GWW citizen monitors in the Rio Pixquiac near Xalapa, in the state of Veracruz, Mexico (see graph above and map at right). The site is monitored by a local rainbow trout farmer, Raphael Hernandez, who diverts water from the river into raceways to rear his trout (pictured above, right). *E. coli* levels have dropped dramatically since monitoring began in January 2006, when *E. coli* levels were 6,467 colonies/100 mL of water. Recent readings (67 colonies *E. coli*/100 mL of water) were well below the 200 colonies/100 mL of water, which is considered the maximum level safe for frequent human contact. GWW-Veracruz have greatly expanded their water quality sampling efforts, and now sample at 31 sites in several watersheds throughout Veracruz.



Determining if a Waterbody is Getting Better or Worse

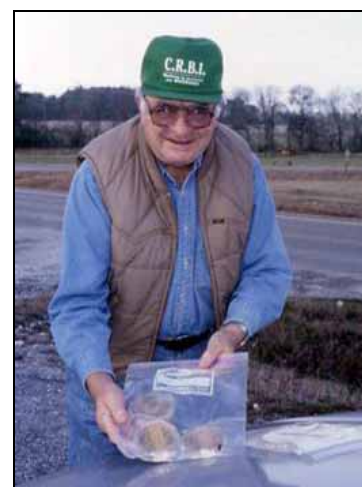
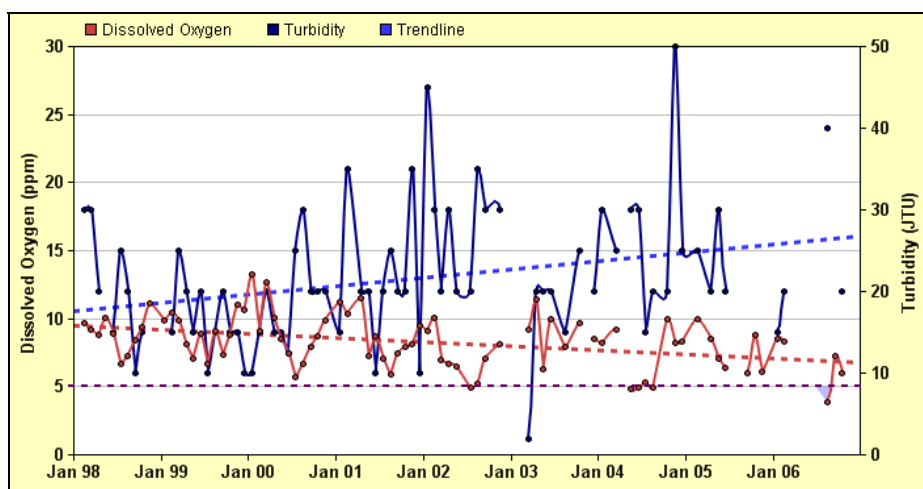
Most volunteer monitors sample their local stream, river, lake or bay to not only determine current water quality conditions, but to also determine if the water quality is getting better or worse over the long haul. For this reason, AWW stresses the importance of consistent monthly sampling over the long term. Many groups have been able to document positive and negative changes in water quality through consistent sampling over several years. Following are two examples of long-term monitoring of water quality by citizen volunteers.

Citizen monitors began monitoring the waters of the Locust Fork River, in Blount County north of Birmingham, Alabama in May of 1993. The trend in turbidity (blue dashed line on graph below) shows that the river's turbidity is on the rise. Many rivers and lakes throughout the South are experiencing increasing turbidity from soil erosion and/or nutrient enrichment, both of which can adversely affect fish and other aquatic life, as well as interfere with lake recreational uses and the quality of drinking water. This section of the Locust Fork River has been 303(d)-listed by ADEM as impaired because of siltation from unidentified sources. The most likely sources of the increasing turbidity are eroded soils washing off disturbed lands within the watershed upstream of this site.



Increasing trend in turbidity (blue dashed line) of the Locust Fork River at Taylor Ford Shoals (site 10001001) near Hendrix, Alabama measured by Friends of Locust Fork River volunteer monitors Nancy Jackson and Susan Finley (pictured above).

Since 1993, Coosa River Basin Initiative (CRBI) volunteer monitors have been monitoring the Upper Coosa River Basin on the Etowah and Oostanaula rivers in Georgia, and downstream of their confluence, the Coosa River, into Alabama and Weiss Lake. CRBI was one of the first AWW groups that extended beyond the borders of Alabama into a neighboring state (in this case, Georgia). Below is a nine year record from Weiss Lake at Cedar Bluff, Alabama. Well-known for its fishing, Weiss, the 'Crappie Capitol of the World' draws fishermen from across the country to its bountiful waters. The lake is formed by the Coosa River in northeast Alabama, and extends from the dam eastward to the Alabama-Georgia state line. Few waterbodies are more affected by the interstate 'Water Wars' than Weiss Lake. The graph below indicates that over the past several years water quality has deteriorated. Similar to the Locust Fork River, water turbidity is on the rise. The citizen data also indicate that DO levels have declined, dipping below the 5 ppm level mandated by ADEM as the minimum level required to maintain a healthy fish population (for waters classified as Fish and Wildlife) in 2006.



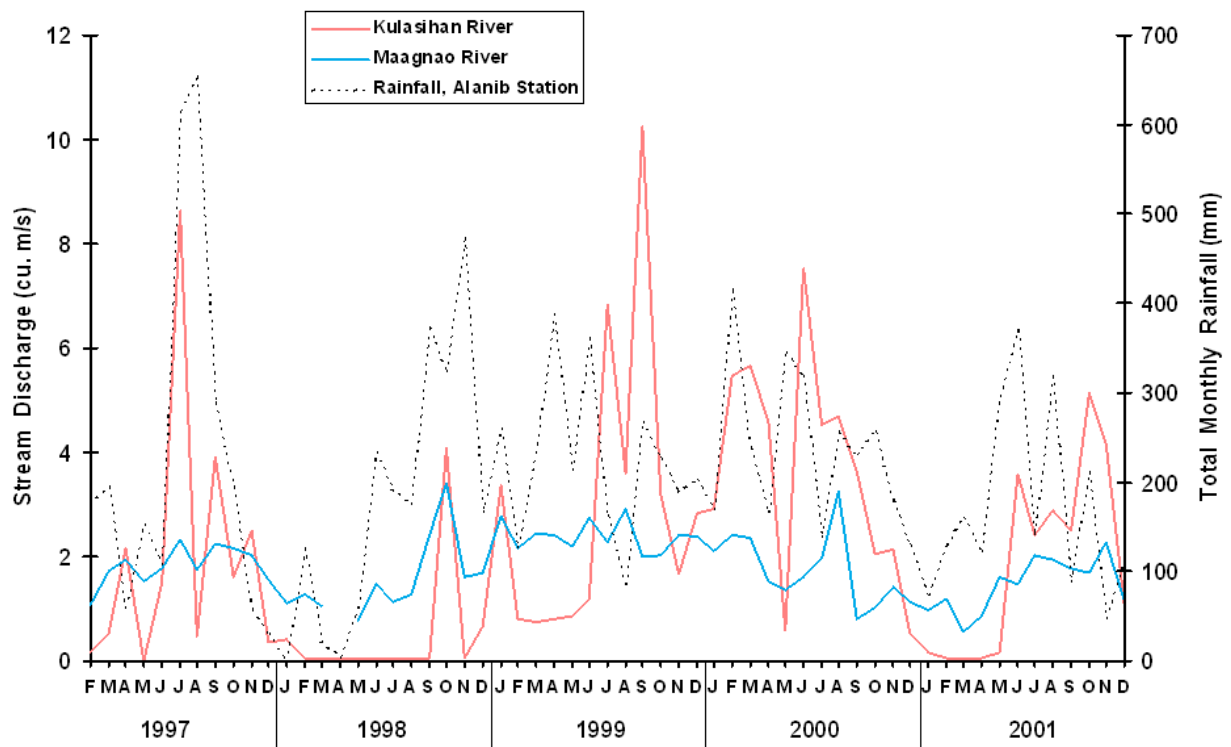
Increasing trend in turbidity (blue dashed line) and decreasing trend in DO (red dashed line) of Weiss Lake (CRBI site 05004062) in Cedar Bluff, Alabama measured by Coosa River Basin Initiative volunteer monitor Ray Kelley (pictured above with *E. coli* plates). Ray was active in environmental issues well before his efforts as one of the founding fathers of CRBI (dating back to the 1950's) and was the first recipient of AWW's recently established 'Ray Kelly Lifetime Achievement Award' for devotion and persistence in watershed stewardship.

Alabamians may not realize that the 'Water Wars' are well underway. Metro-Atlanta already diverts an estimated 23 million gallons per day (mgd) of Coosa River Basin water from the Etowah River (up from 8 mgd in 1968), and plans estimate that this may rise to 100 mgd within the next 30 years. This water withdraw is known as an interbasin-transfer because the water does not return to the Coosa River Basin, it is discharged into the Chattahoochee River. The citizen data above indicate that even at current withdraw levels, the water quality of Weiss Lake is deteriorating – thus, increasing water withdraws will result in greater concentrations of pollutants and further degradation of water quality, which will threaten the 'Crappie Capitol of the World.' For more information on Coosa River Basin issues and CRBI citizen action, visit the CRBI website at www.coosa.org.

Determining the Health of a Watershed – Stream Flow as an Indicator

Citizen monitors in Lantapan Province, Mindanao, the Philippines were the first international monitors to receive water monitor training modeled after the Alabama Water Watch experience. They participated in the "Water Resource Management and Education" phase of a ten-year research program, the Sustainable Agriculture and Natural Resource Management, Collaborative Research Support Program (SANREM CRSP) funded by the U.S. Agency for International Development. The goal of this project was to develop community-based watershed monitoring groups that could collect valid water data and participate in local watershed stewardship. Stream flow monitoring was successfully conducted by trained volunteers in the rural Philippines and the resulting data provided important indicators of watershed health.

Stream hydrographs indicated distinct watershed differences (see graph below). The largely deforested Kulasihan River Watershed had a much greater annual range of flow than the more pristine Maagnao River Watershed, in spite of relatively similar rainfall patterns. Of particular note was the response of the watersheds to the severe El Niño drought which began in the November 1997. The Kulasihan River was dramatically affected by the drought, and went completely dry from March through August 1998. This caused considerable hardship for local residents who depended on the river for washing, watering livestock and, in some cases, gathering household drinking water. Throughout this period, the Maagnao River maintained a relatively stable flow.



Stream discharge and rainfall for the Maagnao and Kulasihan Rivers, tributaries of the Manupali River in Lantapan Province, Mindanao, the Philippines, February 1997- December 2001.



GWW-Veracruz citizen monitors being trained by Alabama Water Watch to measure stream discharge following the protocol developed earlier in the Philippines.

Monitoring Drinking Water Supplies for Bacterial Contamination

The AWW bacteriological monitoring protocol is being used by Brazilians in the Jequitinhonha River Valley in the state of Minas Gerais to test their drinking water for bacteria. Christian Children's Fund of Brazil and Auburn University's International Center for Aquaculture and Aquatic Environments have been collaborating on a water harvesting project since 2001 to assist residents of the Jequitinhonha River Valley in the state of Minas Gerais in the construction of roof catchment rainfall systems to supply household water needs. The systems work well in capturing water, but some are plagued by bacterial contamination. Bacteriological workshops conducted by Auburn University staff, following AWW protocols, have enabled residents to regularly test their catchment systems for bacterial contaminants.



Rooftop catchment system installed for household water supply (above, left) in rural Brazil. Using the AWW bacteriological testing protocol to test residential water supply (above, right).

Environmental Education

Several citizen monitor groups have teamed up with teachers at local schools to provide environmental education field trips to streams, where students learn about the aquatic environment. Over the past decade, citizen volunteer monitors from several groups in Alabama have exposed thousands of children to the intriguing world of stream macroinvertebrates (aquatic insects and worms, snails, and crayfish), and how to determine the health of a stream by examining these creatures. This collaboration between citizen volunteer monitors and schools was pioneered in the early 1990's by LWLM citizen monitors, Dick and Mary Ann Bronson. They began teaching the Alabama Water Watch biological assessment protocol to 5th graders from Montgomery, Alabama at Camp ASCCA in 1994. Mary Ann coined the term *Living Streams* because, when asked if they thought anything lived in the streams, the children's response was "a few frogs, turtles and small fish." They had no knowledge of the multitude of diverse aquatic fauna that inhabit Alabama's streams. During the past 13 years, Lake Watch of Lake Martin volunteers have taught the *Living Streams* program to more than 3000 children in the Lake Martin area, from elementary through high school, community colleges, churches, scouts, and day camps. The program, now called *Exploring Alabama's Living Streams*, is being adapted into a formal school curriculum for grades 4-12.

Exploring Alabama's Living Streams curriculum consists of five modules that include the water environment, ecology of streams, pollution and water quality standards, and stream biomonitoring methods. The curriculum is correlated to meet Alabama State Department of Education Course of Study Standards for 4th and 5th grade science, 6th grade earth science, 7th grade life science, and high

school biology and environmental science classrooms. *Exploring Alabama's Living Streams* has been piloted in seven schools over two years with favorable results.

During a two-year pilot period (2005-2006), a team of teachers, AU Science Education interns and volunteers from local AWW monitoring groups implemented the week-long, six-module curriculum. Students investigated water quality issues in their community, and became familiar with citizen water monitoring groups and agencies involved in water monitoring, policy making and regulation. The curriculum included a field trip to a nearby stream where students conducted a biological assessment following the AWW biomonitoring protocol under the guidance of AWW monitors certified in stream bioassessment. Students participating in the pilot program also participated in the local Alabama Cooperative Extension Service program *Classroom in the Forest*. Radney School 5th grade Science Stanford Achievement Test (SAT) 9 and SAT 10 scores increased from an average of 54% to 71% from 2001-2002 to 2005-2006 school years, over the four year period that the *Exploring Alabama's Living Streams* curriculum and *Classroom in the Forest* were taught. Local educators are excited about this trend, and want to incorporate the curriculum into their yearly teaching schedules.



Lake Watch of Lake Martin citizen monitor, Dick Bronson, teaching Radney School children from Alexander City, AL about stream biomonitoring.



Children assessing stream quality using the AWW biomonitoring protocol.



Save Our Saughatchee citizen monitor, Gene Hunter, teaching Drake School children from Auburn, AL about water testing.

Citizen water data are being used more frequently in formal applications, the following are several examples.

Presentations at Professional Conferences

AWW staff and volunteer monitors have used citizen data in presentations at professional conferences all across the United States and internationally, underscoring the growing importance and value of the citizen data and monitoring efforts. Topics of presentations have ranged from environmental education, to natural-and-unnatural variations in waterbody water quality, to credibility and applications of citizen data. Conferences at which citizen water data have been showcased include the USDA-CSREES National Water Conference, the USDA-CSREES Southern Regional Water Quality Conference, the Southeastern Conference of the North American Lake Management Society, the National Monitoring Conference, the Association of American Geographers Conference, the Alabama Department of Environmental Management Annual Nonpoint Source Conference, the Alabama Science Teachers Association Conference, the Alabama Water Resources Conference, the AmericaView Conference, and the Annual State of Our Watershed Conference – the Tallapoosa River Basin.



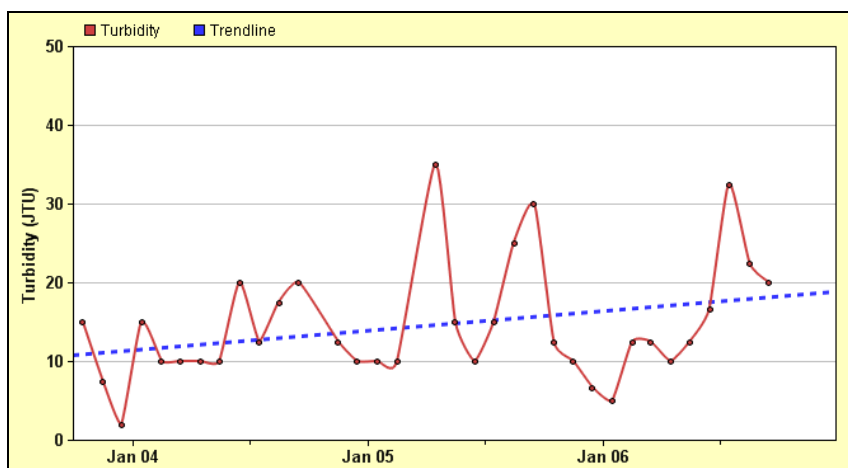
Citizen data and presenters were well-represented at the State of Our Watershed Conference – the Tallapoosa River Basin, held in April 2006 at Camp ASCCA, Jacksons Gap, Alabama. For more information, go to www.twp.auburn.edu.

Influencing Water Policy

A citizen monitor of the Retired Senior and Volunteer Program (RSVP) of Marshall County found extremely high levels of *E. coli* in Lake Guntersville near a public swimming area. The contamination was traced to shoreline flocks of Canada geese, and this data resulted in the passing of a city ordinance which restricted areas where geese could be fed. The change in policy was science-based as well as community-based and made the swimming beach much safer.

Upgrading of a Waterbody – Wolf Bay, Alabama

Wolf Bay Watershed Watch (WBWW) began monitoring water chemistry in the Wolf Bay Watershed in 1996. Wolf Bay is located on the Alabama Gulf Coast east of Mobile Bay. The results of regular monthly citizen monitoring of bacteria and water chemistry over several years indicated that the aquatic flora and fauna of the ecologically-rich bay were threatened by rapid encroachment of development. Certain citizen monitor sites exhibited trends of increasing turbidity and bacteria levels, and low DO levels (see graph below). The increase in turbidity was probably from a combination of eroded soils washing off of the watershed into the bay and increased levels of nutrients (nitrogen and phosphorus) flowing into the bay, which stimulate the growth of algae that turn the water green. Increased turbidity can interfere with aquatic life by limiting light penetration into the water and can adversely affect the recreational and aesthetic value of the bay. Watershed management practices that minimize erosion and nutrient pollution needed to be implemented to reverse this trend.



Increasing levels of turbidity (trend line in blue) monitored by WBWW monitors Nancy and Thomas Duke (pictured above) at their monitoring site on Wolf Bay. Picture - courtesy of Fanfare Photography

Armed with a growing body of watershed-level water quality data, WBWW began pursuing “Outstanding Alabama Water” (OAW) classification for their bay in 2001. If successful, Wolf Bay would be the first bay in Alabama to be upgraded to OAW, and the bay would be protected by more stringent water quality standards and restrictions on development. WBWW provided ADEM with thousands of data records from more than 40 sites monitored throughout the watershed that documented water quality trends in the bay and its tributary streams. With the assistance of AWW, various data analyses were performed for data interpretation presentations, and for two volumes of a Wolf Bay waterbody report, which showcase citizen efforts in watershed stewardship.

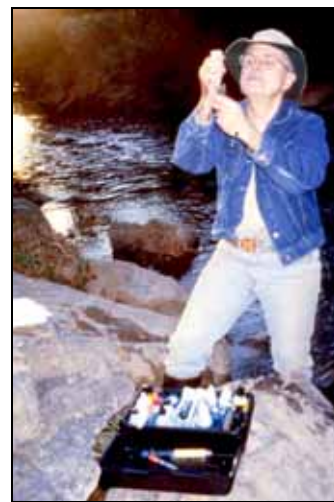
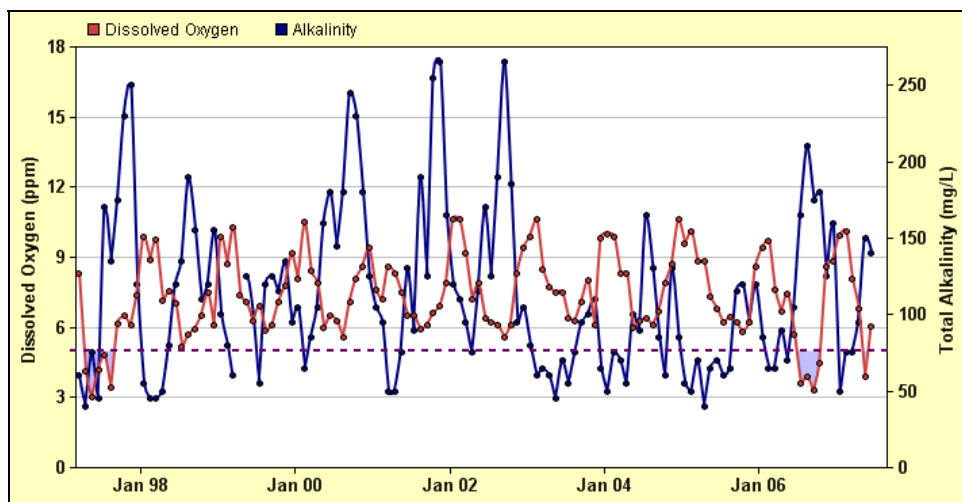
According to the chief of the Water Quality Branch of ADEM, “the Wolf Bay Watershed Watch water quality data was used to pinpoint where the Department needed to focus its monitoring efforts and to highlight areas with potential water quality concerns. In addition, since the WBWW data had highlighted bacteria as a potential parameter of concern, the Department was able to concentrate on collecting bacteriological data for evaluation against the OAW criteria. This allowed ADEM to clearly understand where the OAW classification should be applied.”

In April 2007, after a decade of WBWW citizen efforts including extensive water quality monitoring, development of a watershed management plan, and lots of public outreach, Wolf Bay was granted OAW status by the Alabama Environmental Management Commission. The WBWW executive director credited the achievement to years of citizen water data that verified the bay was deserving of OAW designation.

Development of Watershed Management Plans – SWaMP

The Save Our Saugahatchee (SOS) citizen volunteer monitoring group was formed in 1997 because of concern over degradation of Saugahatchee Creek from both point and nonpoint sources of pollution in and around Auburn, Alabama. Beyond initiation of citizen water quality testing throughout the watershed, an early goal of SOS was to develop a comprehensive watershed management plan that would minimize impacts to the creek as the watershed underwent anticipated rapid development. Several SOS members were instrumental in the formation of the Saugahatchee Watershed Management Plan (SWaMP) stakeholder group in 2004. The SWaMP stakeholder group was composed of individuals from local government, business/industry, academia and community groups. Primary goals of SWaMP were to draft a watershed management plan for the Saugahatchee Creek Watershed, and to obtain grant funding to implement the plan. SOS monitors and their water data were

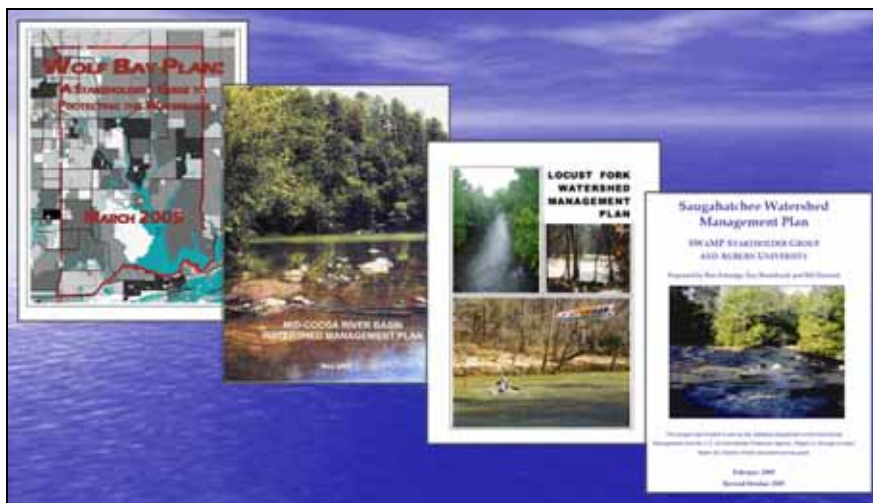
important sources of information for fulfilling requirements of the plan regarding 1) identification of water pollution problems, 2) development of information/education components, and 3) development of stream water quality monitoring components of the plan. These were three of nine required elements that all watershed management plans must address to receive EPA/ADEM funding.



Ten-year trends in DO and alkalinity of Saugahatchee Creek at North Donahue Bridge measured by David Newton (pictured above). The data indicate that alkalinity, associated with a textile mill point source discharge, became very high (often greater than 200 mg/L) during summer low-flow periods. These periods were also characterized by low DOs, which recently (summers of 2006 and 2007) dropped below the ADEM-mandated level of 5ppm for waters classified as Fish and Wildlife.

The SWaMP stakeholder group completed the Saugahatchee Watershed Management Plan in 2005, following an 18-month process of more than 20 meetings, and submitted an application to ADEM for funding Phase 1 Implementation of SWaMP (the first 3 years of the 9-year plan). SWaMP was funded in early 2007, and SOS continues its strong involvement in environmental outreach and implementation of on-the-ground BMPs to reduce the flow of nonpoint source pollution into the creek. Additional information on SWaMP efforts can be found at www.swamp.auburn.edu.

Many other AWW citizen monitoring groups have been actively involved in developing and implementing watershed management plans. Examples include the Wolf Bay Watershed Watch and the *Wolf Bay Plan*, the Logan Martin Lake Protection Association and the *Mid-Coosa River Basin Watershed Management Plan*, and the Friends of Locust Fork River and the *Locust Fork Watershed Management Plan*.



Sustainability of Citizen Water Quality Data

Data quality and usefulness is not a purely technical issue. In AWW's one and a half decades of experience in directing citizen water monitoring, we have learned that quality assurance plans and good protocols are not enough to sustain quality volunteer monitoring over the long term. Quality, long-term data comes from satisfied, engaged volunteer monitors who feel that their data is used and is making a difference. AWW addresses monitor satisfaction through several avenues. The AWW website provides citizen monitors with timely feedback by displaying their sites on maps and their data in several graphic forms. The AWW Program office provides volunteer monitor support through coordinating and conducting several levels of training and certification, waterbody data interpretation presentations to groups, assistance in creating and publishing waterbody reports that showcase group efforts, replenishing monitor test kits with fresh chemicals, and day-to-day technical assistance via email, telephone and personal contact.



Bill Deutsch, AWW Program Manager, and Sergio Ruiz-Córdova, AWW Database Specialist, conduct training in water chemistry testing in Huntsville, AL in November 2006.



AWW Volunteer Coordinator, Tia Gonzales, distributes new chemicals to water chemistry monitors at Lake Wedowee, AL.

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For more information...

Concerned citizens, young and old, now have a powerful, new tool to answer the fundamental questions of water testing: *Is my water body getting better or worse, and why?* Hundreds of summary graphs and maps of water data, training opportunities, special meetings and other aspects of water monitoring are available at the AWW and GWW websites. Certified monitors can enter their data online, and custom graphs and statistical trends of water quality data can easily be generated.



Let's keep the wonder alive!

Timely dissemination of quality-assured water quality data in meaningful ways is a vital element of a successful volunteer monitoring program. It is important to apply water quality information collected by citizen volunteers to local activities such as environmental education, waterbody protection and restoration, and development of watershed management plans. You are welcome to become a part of AWW/GWW and a water monitoring group.



Alabama Water Watch is a citizen volunteer water quality monitoring program that provides training, data management, information exchange and other means of support for the public to become personally involved in water issues. Global Water Watch is a network of community-based water monitoring groups worldwide, coordinated from Auburn University.

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