Tallapoosa Watershed Project

prepared for

CSREES
Cooperative State Research, Education and Extension Service
U. S. Department of Agriculture

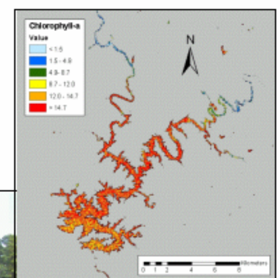
by

Department of Fisheries and Allied Aquacultures
Auburn University

A Transferable Model of Stakeholder Partnerships for Addressing Nutrient Dynamics in Southeastern Watersheds

Annual Report

2005



May 2006

List of Abbreviations

ACES ……………………..……. Alabama Cooperative Extension System
ASCCA ……………….……........... Alabama Special Camp for Children and Adults
AU…………………………....…..Auburn University
AWW………………………….…….Alabama Water Watch
CSREES ………………………… Cooperative State Research, Education and Extension Service
LWLM. ………………………… Lake Watch of Lake Martin
LWPOA…………………………..Lake Wedowee Property Owners Association
MTRBCWP ……………..……… Middle Tallapoosa River Basin Clean Water Partnership
TRBCWP ……………… ……... Tallapoosa River Basin Clean Water Partnership
UA ………………………………. University of Alabama

TALLAPOOSA WATERSHED PROJECT

Annual Report – 2005

Year 2

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

The Tallapoosa Watershed Project (TWP) is a three-year project, which began on September 15 2003, following a series of planning meetings by researchers, educators and other stakeholder groups. The TWP is an integrated project (research, education and outreach components) funded by USDA/CSREES (Project Number ALA09-051, CRIS Number 0197353). This progress report documents activities and accomplishments of the project's second calendar year (January-December 2005), which concentrated on the aquatic environments and watersheds of Lake Martin and Lake Wedowee of the Middle and Upper Tallapoosa River Basins.

The **Auburn University (AU)** research team, from the AU Department of Fisheries and Allied Aquacultures, made seven monthly trips to Lake Wedowee from April through October 2005 to measure chlorophyll a, total nitrogen (TN), total phosphorus (TP), soluble reactive phosphorus (SRP), total suspended solids (TSS), pH, alkalinity, hardness, turbidity, conductivity, water temperature, dissolved oxygen and Secchi disk visibility at 14 sites on the lake following *Standard Methods* protocols. Lake sampling was done on both a photic zone composite sample and a 0.5-meter deep sample. The 0.5-meter deep sample was collected specifically for correlation with spectral reflectance analyses. AU also measured TN, TP, SRP, TSS, pH, alkalinity and discharge from six stream sites, three river sites and two point sources (waste-water treatment plants) monthly, January-December 2005 (the same sites sampled in 2004). Streams were also sampled eight times after significant rainfall/runoff events. Gage data was periodically downloaded from stream gages that were installed in 2004 on the six streams (four agricultural and two forested) for the continuous monitoring of water level for developing hydrographs to be used in estimating nutrient and sediment loading. Fish communities were sampled from the six TWP streams and from Mill Creek (below one of the wastewater treatment plants) to determine stream quality.

The **University of Alabama (UA)** research team, from the UA Department of Geography, made seven monthly trips to Lake Wedowee from April through October 2005, coincident with the AU team and the Landsat satellite overpass to perform close-range hyperspectral analyses of lake surface waters. Transport of UA researchers on Lake Wedowee was provided by Lake Wedowee Property Owners Association (a volunteer citizen water quality monitoring group). Hyperspectral analyses were conducted using a high-end spectrometer (ASD FieldSpec UV/VNIR). Surface water spectral reflectance values were correlated to Standard Methods lake chlorophyll a values to develop algorithms that predict chlorophyll a concentrations throughout the lake. Satellite images were purchased for analyses of watershed land use/land cover and mapping of lake chlorophyll a concentrations. A color-coded chlorophyll a map of Lake Wedowee was generated for April 2005. The GIS-based SWAT model was utilized to generate estimates of nutrient (nitrogen and phosphorus) and sediment loads from all subwatersheds of the Middle and Upper Tallapoosa Basins.

Alabama Water Watch (AWW), a state-wide program dedicated to developing citizen volunteer monitoring of Alabama's lakes, streams and coastal waters, conducted two workshops on the approach of the TWP and stream bioassessment for 10 pre-service teachers at Auburn

University and 45 sixth-grade students at an Auburn-area middle school. The weeklong *Living Streams* curriculum (grades 6-12), developed by the TWP Education team, was piloted in four schools, with positive response and comments for improvements. A poster and brochure featuring the *Living Streams* curriculum were developed.

Alabama Cooperative Extension System (ACES) conducted instruction about the TWP and watershed management during *Classroom in the Forest* sessions at five schools to 746 students, and during *Enviroscape* watershed model demonstrations at three schools to 408 students.

Alabama Department of Environmental Management (ADEM), the state agency that oversees monitoring of and regulating discharges to Alabama's waters, sampled water quality monthly throughout the growing season at six sites on Lake Wedowee and at 11 sites on Lake Martin using *Standard Methods* in the field and laboratory. In addition to their routine sampling of lake photic zone composite samples, ADEM collected and analyzed 0.5-meter deep samples at six of their sites on Lake Martin specifically for correlation with spectral reflectance analyses conducted by citizen volunteers of Lake Watch of Lake Martin.

Lake Watch of Lake Martin (LWLM), a volunteer citizen monitoring group on Lake Martin, measured water quality monthly, April-October 2005 (coincident with ADEM *Standard Methods* sampling) at five open-water sites on Lake Martin using the AWW test kit for six physicochemical parameters (water temperature, pH, alkalinity, hardness, turbidity and dissolved oxygen), TSS and Secchi disk visibility. Water samples were processed for TSS at the Alexander City Sugar Creek Wastewater Treatment Plant Laboratory in partnership with the city of Alexander City. Close-range hyperspectral remote sensing of water quality was conducted with a relatively low-cost StellarNet EPP2000C spectroradiometer for correlation with lake chlorophyll a concentrations and for comparison to the high-end spectroradiometer of UA. Side-by-side hyperspectral analyses were conducted with UA's high-end spectrometer on two dates to compare and confirm performance. Chromaticity (color quality of light quantified as three coordinates) of filtrate from filtered water samples was measured using a digital camera and the StellarNet spectroradiometer to correlate with lake chlorophyll a concentrations.

Lake Wedowee Property Owners Association (LWPOA), a volunteer citizen monitoring group on Lake Wedowee, provided boat transportation for the UA team and also sampled coincident with AU, UA and ADEM, using the AWW test kit for six physicochemical parameters and Secchi disk measurements.

TWP Directors Meetings were held in March and September 2005 for overall project planning and coordination.

The **TWP Research Team** met twice in January and once in November 2005, and the **Education/Outreach Team** met in April 2005 for project planning and coordination.

TWP updates were presented at two Tallapoosa River Basin Clean Water Partnership meetings.

A First Annual ***State of Our Watershed Conference – The Tallapoosa River Basin*** was held on May 5-6, 2005 at Camp ASCCA (Alabama's Special Camp for Children and Adults), Jacksons

Gap, AL. The first day of the conference summarized TWP research, as well as that of other local, state and federal agencies, and its applications to management of the Tallapoosa River Basin. On the second day, TWP education and outreach activities were shared with local teachers and students. A total of 140 people attended the conference.

TWP presentations were made at the Alabama Fisheries Association Annual Meeting, January 25th in Auburn, AL; at the Alabama Science Teachers Association Annual Conference, October 4th in Birmingham, AL; at the Alabama Water Resources Conference, October 13th in Orange Beach, AL; and at the USDA/CSREES Southern Region Water Quality Conference, October 23rd in Lexington, KY.

Abstracts were accepted at three professional conferences to be held in 2006 (USDA/CSREES National Water Conference, Feb. 5-9 at San Antonio, TX; Annual Meeting of the Association of American Geographers, March 7-11 at Chicago, IL; NALMS 15th Annual Southeastern Lake & Watershed Management Conference, March 8-10 at Columbus, GA).

The TWP project has collaborated with four **Related Projects** in the Tallapoosa Basin for mutually beneficial activities and additional financial resources, including: 1) Tallapoosa Clean Water Partnership and Lake Wedowee Property Owners Association (stream bioassessment using fish communities), 2) AU Environmental Institute grant to the AU Fisheries Department (teacher workshops and interns in classrooms), 3) CSREES grant to the Alabama Cooperative Extension System (rain gardens and environmental education), and 4) Alabama Cooperative Extension System (*Classroom in the Forest* and *Enviroscape* programs).

Project partners have regularly updated research and outreach activities, presentations, photos and meeting minutes on the **TWP intranet**.

TWP research, education and outreach activities have been updated regularly on the **TWP website,** *www.twp.auburn.edu*.

II. PROJECT BACKGROUND

• Directors, Collaborators and Partners

Project Directors

Dr. Bill Deutsch
Project Director (PD) Research Fellow, Department of Fisheries and Allied Aquacultures, Auburn University (AU)

Dr. David Bayne
(Co-PD) Professor, Department of Fisheries and Allied Aquacultures, AU

Dr. Luoheng Han
(Co-PD) Professor, Department of Geography, University of Alabama

John Glasier
(Co-PD) Vice President Lake Watch of Lake Martin

Robin Nelson

(Co-PD) Environmental Education Specialist, Alabama Department of Education (ADE) (March 2003-August 2004), Montgomery, Alabama

Sallye Longshore

(Co-PD) Environmental Education Specialist, ADE (September 2004 to present), Montgomery, Alabama

Collaborators

Eric Reutebuch

Project Coordinator, Research Associate, Department of Fisheries and Allied Aquacultures, AU

Tommy Futral

Tallapoosa County Extension Coordinator, Alabama Cooperative Extension System (ACES) and Chairman of the Executive Board of Directors of the Middle Tallapoosa River Basin Clean Water Partnership

Wendy Seesock

Research Associate, Department of Fisheries and Allied Aquacultures, AU

Fred Leslie

Chief – Montgomery Branch, Field Operations Division, Alabama Department of Environmental Management (ADEM)

Charles Eick

Associate Professor, Department of Curriculum and Teaching, AU

Dick Bronson

President, Lake Watch of Lake Martin (LWLM)

Charles Smith and Jack Duncan

Director and Technical Coordinator, Lake Wedowee Property Owners Association (LWPOA)

Stan Roark

Randolph County Extension Coordinator, Alabama Cooperative Extension System (ACES)

Omar Romagnoli

TWP webmaster, Project Coordinator (June 2004- December 2004), Department of Fisheries and Allied Aquacultures, AU

Jenny Fuller

Graduate research assistant, Department of Fisheries and Allied Aquacultures, AU

Partner Institutions

Alabama Department of Environmental Management (ADEM)

ADEM is the state agency responsible for enforcing rules and regulations to protect and improve the quality of Alabama's environment and the health of all its citizens.

Alabama Cooperative Extension System (ACES)

ACES, the primary outreach organization for the land-grant mission of Alabama A&M University and Auburn University, delivers research-based educational programs that enable people to improve their quality of life and economic well-being.

Alabama Special Camp for Children and Adults (ASCCA)

The Camp ASCCA Mission is to help children and adults with disabilities achieve equality, dignity, and maximum independence through a program of camping, recreation, and education.

Alexander City Schools

The Alexander City Schools, headed by Superintendent Tommy Bice, includes five public schools ranging from elementary through high school whose teachers and students are direct beneficiaries of the project's environmental education initiatives.

City of Alexander City

Alexander City, situated adjacent to Lake Martin, is the largest municipality in the Middle Tallapoosa watershed. The Alexander City mayor is the MTRBCWP representative to the Tallapoosa River Basin Clean Water Partnership Steering Committee.

Lake Watch of Lake Martin (LWLM)

The main goal of LWLM is to maintain, improve and protect Lake Martin and surrounding waters through citizen volunteer water quality monitoring, education/outreach activities and working proactively with governmental and non-governmental organizations within the Tallapoosa River Basin and throughout the state.

Lake Wedowee Property Owners Association (LWPOA)

The main goal of LWPOA is to enhance, improve and protect the quality of Lake Wedowee and to promote the welfare of the lake community through education and other means.

Tallapoosa River Basin Clean Water Partnership (TCWP)

TCWP is a coalition of public and private individuals, companies, organizations and governing bodies working together to protect and preserve water resources and aquatic ecosystems of the Tallapoosa Basin.

Tallapoosa County Schools

The Tallapoosa County School District, headed by Superintendent Ginger East, includes seven public schools ranging from elementary through high school whose teachers and students are direct beneficiaries of the project's environmental education initiatives.

• Project Description

The TWP integrates a variety of research, education, and extension activities to provide relevant, locally-generated watershed information.

Research will result in a comprehensive assessment of nutrient and sediment concentrations and loading in the Tallapoosa River Basin and also compare the cost-efficiency of three levels of monitoring technology, high-tech (remote sensing), *Standard Methods* (APHA 1998), and low-tech (citizen volunteer data).

Research results are being adapted for education in the form of in-classroom curricula and teacher workshops.

Research results are available to stakeholder groups through the TWP website at *www.twp.auburn.edu*.

The project will benefit the research, outreach and resource management aspects of ADEM and the Tallapoosa River Basin Clean Water Partnership, and should be adaptable for other southeastern watersheds.

• Project Objectives

The overall goal of this three-year project is to develop cost-effective options for assessing and managing nutrient and sediment loading of surface waters on a watershed scale, and to convey information related to nutrients and other aspects of water quality to a broad range of stakeholders.

The TWP has four components, which relate to research, education and extension objectives:

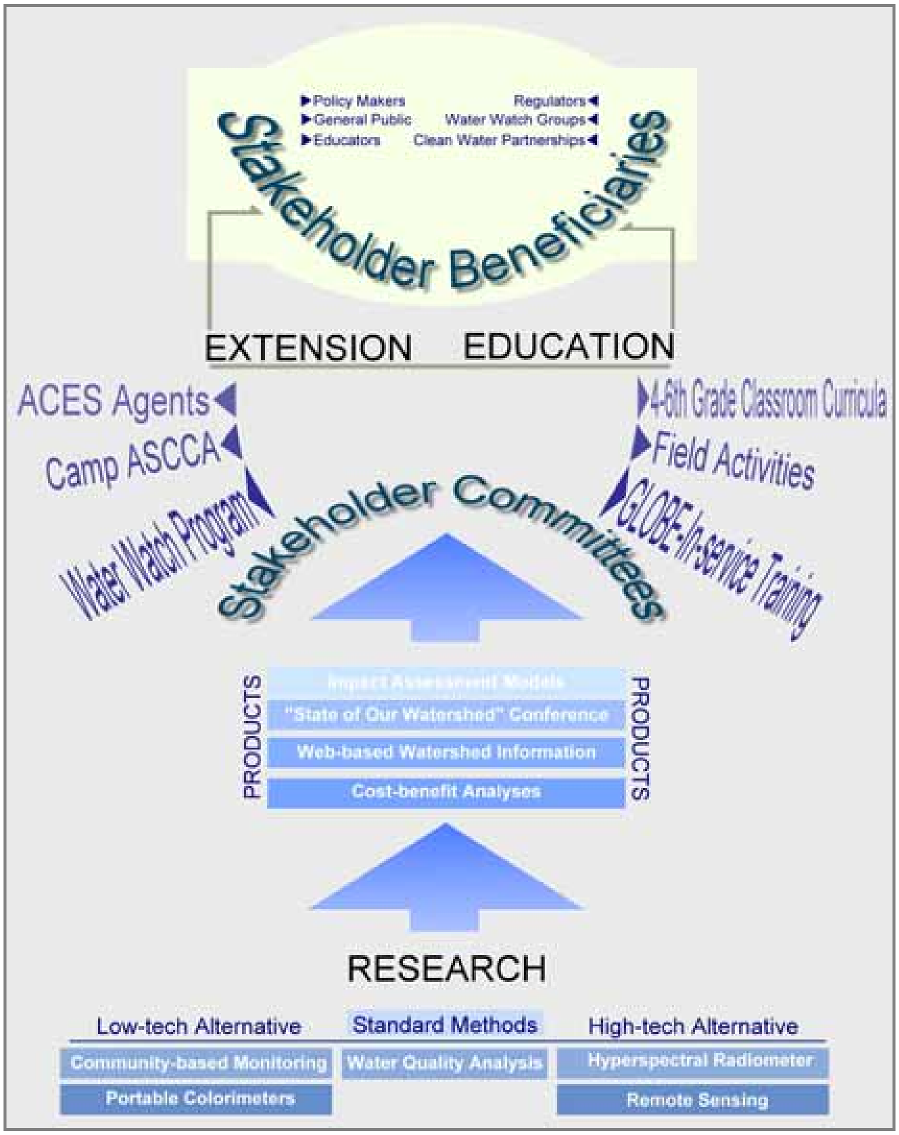
1) Quantify nutrient and sediment loading in the Tallapoosa River Basin using *Standard Methods* in field and laboratory analyses,

2) Develop both high-tech (remote sensing and GIS/modeling) and low-tech (citizen volunteer monitors) options for assessing nutrients and sediment in surface waters,

3) Communicate project results to diverse stakeholder groups through web-based technology, high profile community outlets and middle school educational programs (in-class curricula and field activities) and,

4) Establish an institutional framework and decision-support system that complements the existing Alabama Clean Water Partnership.

The approach is intended to be transferable to other watersheds in the southeastern U. S. and to be readily adaptable and relevant to Alabama's future water quality trading program.



A Model of the Tallapoosa Watershed Project

III. PROJECT MANAGEMENT

• Project Directors Meetings

Project Directors and partners met to review progress and plan for TWP implementation.

1. Planning Meeting: March 1, 2005. Wedowee, AL.
Participants discussed Lake Wedowee Property Owners Association participation in TWP sampling on Lake Wedowee, status of the TWP budget, plans for the upcoming (May 2005) *State of Our Watershed Conference*, possible publications, and Lake Watch of Lake Martin sampling needs. Attendees: Bill Deutsch, David Bayne, Luoheng Han, John Glasier, Sallye Longshore, Eric Reutebuch, Tommy Futral, and Dick Bronson.

TWP planning meeting in Wedowee, Alabama, March 2005

2. Data Review and Planning Meeting: September 9, 2005. Camp ASCCA, Jacksons Gap, AL.
Participants discussed status of the TWP budget, TWP reports and publications, plans for the 2006 *Second Annual State of Our Watershed Conference,* activity reporting on the TWP intranet, and interest in pursuing new project funding. Attendees: John Glasier, Dick Bronson, Bill Deutsch, David Bayne, Eric Reutebuch, Wendy Seesock, Tommy Futral, Jenny Fuller, Omar Romagnoli and Dan Gilliland (Camp ASCCA Program Director).

• TWP Presentations at Conference and Meetings

TWP representatives presented project overviews and updates at several professional conferences and meetings in 2005.

Conference Presentations

1. Alabama Fisheries Association Annual Conference: January 25, 2005. Auburn, AL.
Bill Deutsch and Eric Reutebuch gave a presentation entitled "Integration of Research, Education and Extension for Addressing Nutrient Dynamics in Southeastern Watersheds." Luoheng Han gave a presentation entitled "Integration among *In-Situ* Sampling, Remote Sensing and GIS." Attendees were from all over the state of Alabama (see abstract in Appendix B).

2. Alabama Science Teachers Association Annual Conference: October 4, 2005. Birmingham, AL. Charles Eick gave a presentation entitled "Linking Alabama Water Watch to your Environmental Science Course and Community." Attendees were educators from all over the state of Alabama.

3. Alabama Water Resources Annual Conference: October 13, 2005. Orange Beach, FL. Jenny Fuller presented a poster entitled "Living Streams - Improving Aquatic Science Education in Alabama by Linking Alabama Water Watch Volunteers to Classrooms." Attendees were from all over the state of Alabama.

4. USDA CSREES Southern Region Water Quality Conference: October 25, Lexington, KY. Bill Deutsch gave a presentation entitled "An Integrated Approach to Research, Outreach and Management in the Tallapoosa River Basin, Alabama." Luoheng Han gave a presentation entitled "Monitoring Water Quality and Nutrient Dynamics for the Middle Tallapoosa Watershed Using Remote Sensing and GIS Techniques." Attendees were from all over the southeast (see abstract in Appendix B).

Meeting Presentations

1. Middle Tallapoosa River Basin Clean Water Partnership Stakeholders Meeting: January 18, 2005. Alexander City, AL. Bill Deutsch and Eric Reutebuch presented on the overall progress and some of the 2004 research results of the TWP to the MTRBCWP Stakeholders. Attendees: Tommy Futral, John Glasier, Bill Deutsch, Eric Reutebuch, Dick Bronson, Mayor Barbara Young, Mayor Bruce Albright, Malene McElroy and several other MTRBCWP stakeholders.

2. Lake Wedowee Property Owners Association Annual Meeting: March 19, 2005. Wedowee, AL. Bill Deutsch gave a presentation to Lake Wedowee Property Owners Association members entitled "Crystal Clear or Pea Soup – What's the Future of Lake Wedowee?" The talk focused on nutrient standards for the lake. About 30 people attended.

3. Sierra Club Meeting: May 19, 2005. Troy, AL. Bill Deutsch gave an update about the TWP, Alabama Water Watch and Global Water Watch in a presentation entitled, "Community-Based Water Monitoring: Improving Water Quality and Policy in Alabama and the World." About 25 people attended.

4. Tallapoosa River Basin Clean Water Partnership Steering Committee Meeting: August 24, 2005. Montgomery, AL. Charles Smith of LWPOA gave a presentation entitled " Lake Wedowee – The Misunderstood Lake in the Tallapoosa River Basin." Attendees included numerous stakeholders from the entire Tallapoosa River Basin.

5. Alabama Cooperative Extension Service Natural Resources Training: October 4, 2005. Auburn, AL. Bill Deutsch gave a presentation entitled, "Alabama Water...and What Citizens are Doing About It," to a group of about 15 county agents and coordinators of the Alabama Cooperative Extension System as part of a series of Natural Resource Training Sessions.

• Resource Development

Written and electronic resources were designed and developed for communication of TWP activities, accomplishments and impacts to project partners, educators and the general public.

1. TWP Intranet.

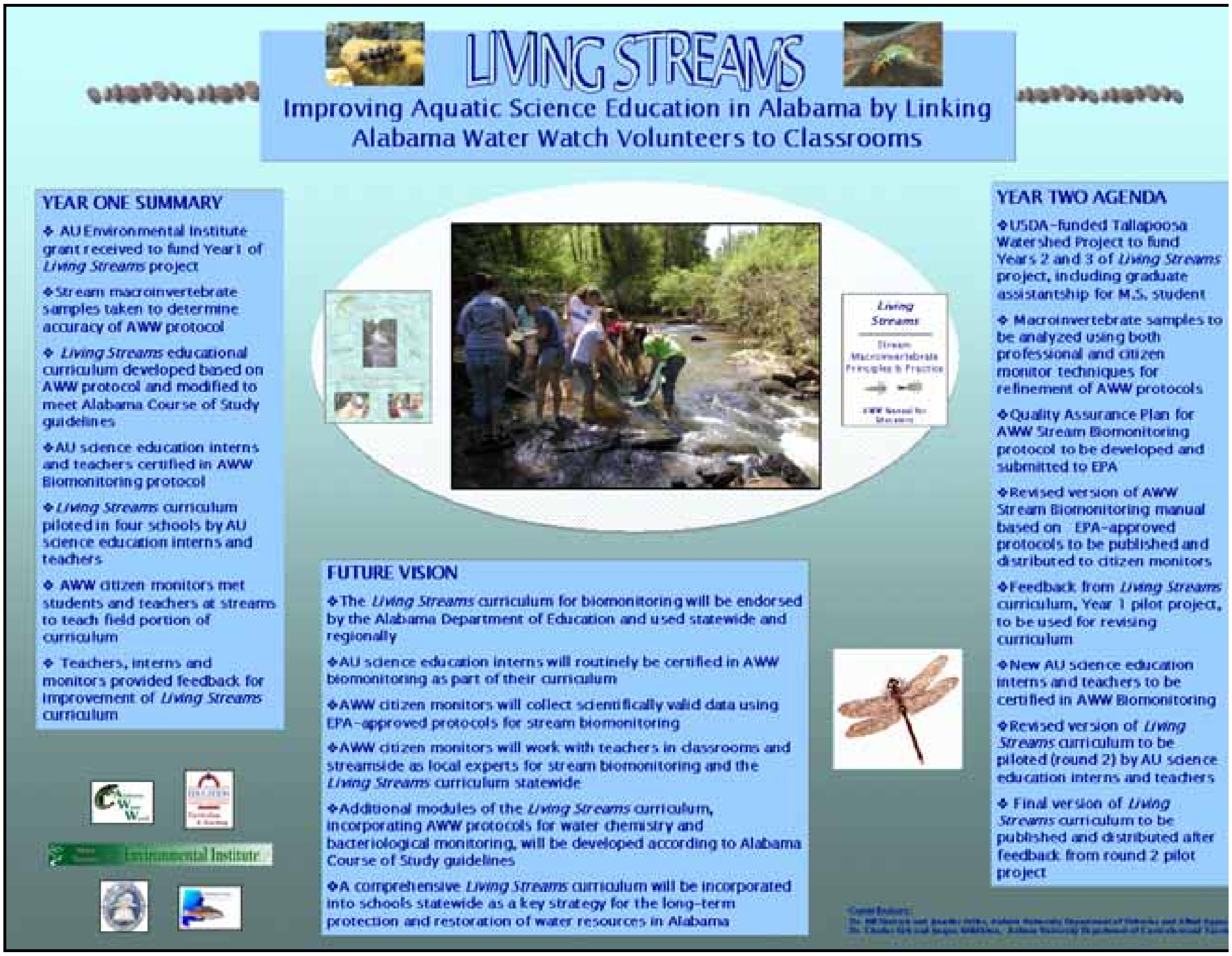
The TWP Intranet acts as both an archive of all TWP activities, in the form of reports, photos, maps, presentations and meeting proceedings, and as a communication tool for project partners. Project activities are updated regularly by project partners.

2. TWP Website.

The TWP website (*www.twp.auburn.edu*) contains a wealth of information for the public on project research, education and outreach activities and results, as well as information on related projects that the TWP collaborates with for mutually beneficial activities in the Tallapoosa Basin and additional financial resources. There is also a posting of relevant past and upcoming conferences. The website resides on the FrontPage server at Auburn University.

3. *Living Streams* Poster.

The *Living Streams* poster was composed to communicate TWP curriculum development efforts to the public (available at *www.twp.auburn.edu/EduCurriculadevelop.aspx*). The poster has been displayed at several meetings and conferences.



Poster featuring the Living Stream curriculum

4. Environmental education brochure. The TWP Education team created a brochure entitled ‘Enhancing Aquatic Science Education in Alabama’ explaining the development of the *Living Streams* curriculum and its benefits to classrooms in Alabama (available at *www.twp.auburn.edu/EduCurriculadevelop.aspx*).

• Reports and Publications

1. CRIS/CSREES AD-421 Progress Report. A TWP 2005 annual progress report was submitted online by the project coordinator to the Current Research Information System of the CSREES website (available at http://cris.csrees.usda.gov).

2. A Transferable Model of Stakeholder Partnerships for Addressing Nutrient Dynamics in Southeastern Watersheds – 2004 Annual Report. An in-depth annual report was compiled by the project coordinator (available at *www.twp.auburn.edu/ResConferences.aspx*). Sixteen copies were printed for project partners and state and local stakeholders and policy makers.

• **Submitted Abstracts**

1. Innovations in understanding basin-scale nutrient dynamics. Submitted by Bill Deutsch to the USDA CSREES National Water Conference, San Antonio, Texas, February 5-9, 2006 (see Appendix B).

2. Estimating water quality in a man-made lake in Alabama using multi-temporal spectral reflectance. Submitted by Luoheng Han to the Association of American Geographers Annual Meeting, Chicago, Illinois, March 7-11, 2006 (see Appendix B).

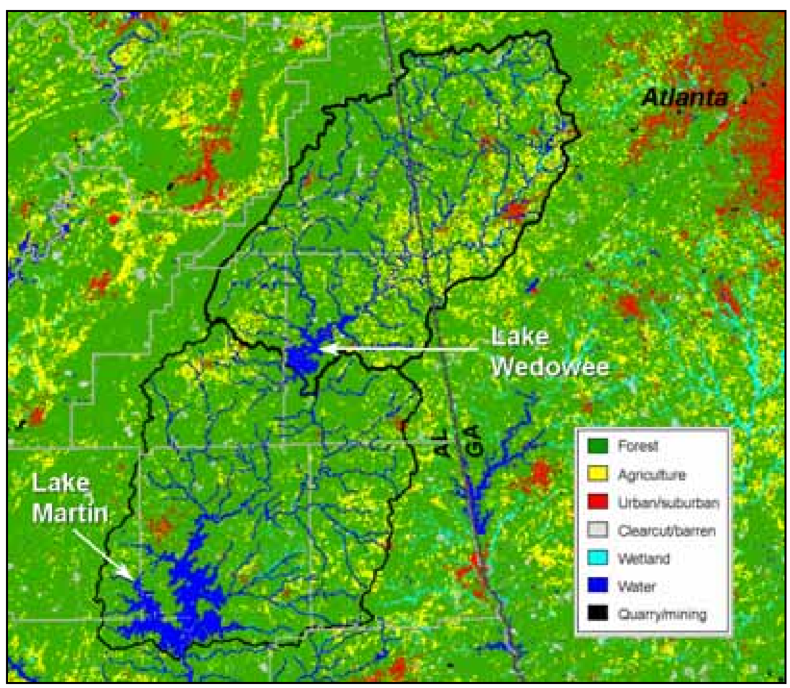
3. Alternative capabilities for volunteer monitoring the trophic status of Lake Martin, Alabama. Submitted by John Glasier and Richard Bronson to NALMS Southeastern Lake and Watershed Management Conference, Columbus, Georgia, March 8-10, 2006 (see Appendix B).

4. A Transferable Model of Stakeholder Partnerships for Addressing Basin-scale Nutrient Dynamics. Submitted by John Glasier and Richard Bronson to NALMS Southeastern Lake and Watershed Management Conference, Columbus, Georgia, March 8-10, 2006 (see Appendix B).

IV. RESEARCH

Research was conducted in both the Upper and Middle Tallapoosa River basins by university (Auburn University and the University of Alabama), state agency (the Alabama Department of Environmental Management) and certified volunteer citizen monitoring groups (Lake Watch of Lake Martin and Lake Wedowee Property Owners Association) during 2005.

Location of the Tallapoosa Watershed



Location of lakes Wedowee and Martin with 1992 land use

• **Research Team Meetings**

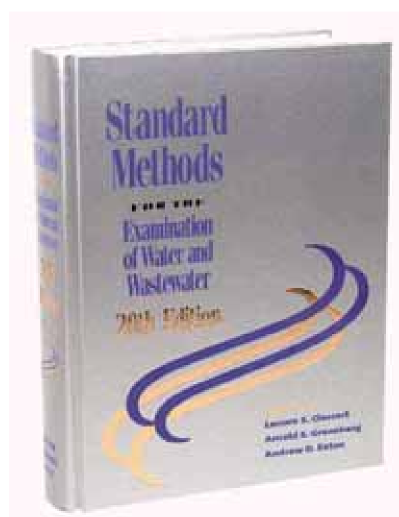
1. Research Team Meeting: January 11, 2005. Auburn, AL. Participants discussed the coordination of upcoming 2005 field sampling by citizen volunteer monitors (Lake Watch of Lake Martin) on Lake Martin – sample site locations on the lake, shoreline versus open-water sampling, colorimeter and total suspended solids (TSS) analyses, and low-end hyperspectral sampling. Also discussed was citizen volunteer monitor participation in 2005 Lake Wedowee sampling. Attendees: Bill Deutsch, John Glasier, Dick Bronson and Eric Reutebuch.

2. Research Team Meeting: January 25, 2005. Auburn, AL. Participants discussed the coordination of upcoming 2005 field sampling strategy on lakes Martin and Wedowee – sampling needs, ADEM sampling (ADEM agreed to do additional 0.5 meter-deep sampling at select sites on Lake Martin for the TWP), recruitment of Lake Wedowee Property Owners Association citizen monitors to assist in TWP sampling efforts on Lake Wedowee (both in side-by-side water chemistry sampling with the AU team and possibly providing transportation via boat for the UA remote sensing team), site selection on Lake Wedowee, utility of TWP data to ADEM, progress of modeling and chlorophyll mapping, reporting of TWP activity on the TWP intranet and a budget update. Attendees: Bill Deutsch, Luoheng Han, John Glasier, David Bayne, Dick Bronson, Eric Reutebuch, Wendy Seesock, Omar Romagnoli, Fred Leslie (ADEM), Gina LoGiudice (ADEM), Greg Vinson (ADEM) and Russel Taylor.

3. Research Team Meeting: November 18, 2005. Camp ASCCA, Jacksons Gap, AL. Participants reviewed progress and preliminary results of 2005 field research on lakes Martin and Wedowee, and discussed future research needs. Attendees: Bill Deutsch, Luoheng Han, John Glasier, David Bayne, Dick Bronson, Eric Reutebuch, Tommy Futral, Cliff Webber, Omar Romagnoli, Chris Johnson (ADEM), Gina LoGiudice (ADEM), Greg Vinson (ADEM), Jack Duncan (LWPOA), Gleason Poole (LWPOA), and Jack McKay (LWPOA).

• **Auburn University Research**

The field and laboratory sampling and analyses performed by Auburn University, as well as that performed by ADEM, is referred to as *Standard Methods* in this report. *Standard Methods* refers to the standardized field and laboratory sample collection and analysis methods of water in the text: *Standard Methods for the Examination of Water and Wastewater,* published by the American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation (WEF).



1. Watershed Sampling.

Sampling was conducted at 11 watershed sample sites (stream, river and point source sites, see table below, and Figure 1, Appendix C for map).

Watershed Sample Site	Code	Dominant Land Use	Lat	Lon	Watershed Area (acres)
1. Birdsong Creek	F-1	Forest	33.0725	-85.7389	3,425
2. Grants Branch	A-1	Agriculture	33.3189	-85.4693	1,909
3. Jones Creek	F-2	Forest	33.0936	-85.8510	2,943
4. Pine Hill Creek	A-2	Agriculture	33.4458	-85.3923	629
5. Prairie Creek	A-3	Agriculture	33.3497	-85.7442	2,710
6. Rice Branch	A-4	Agriculture	33.4386	-85.3652	798
7. Little Tallapoosa River at CR 82	R-1	N/A	33.4372	-85.3992	259,840
8. Tallapoosa R. below Harris Dam	R-2	N/A	33.2578	-85.6157	935,680
9. Tallapoosa R. at Horseshoe Bend	R-3	N/A	32.9766	-85.7405	1,317,120
10. Dadeville WWTP(Chattosofka Creek)	PS-1	Urban	32.8161	-85.7606	N/A
11. LaFayette WWTP (Mill Creek)	PS-2	Urban	32.9061	-85.4356	N/A

Streams were classified by the land use/land cover (LU/LC) occupying their watersheds as either forest (silvicultural) - Birdsong Creek, F-1, and Jones Creek, F-2; or agricultural- Grants Branch, A-1, Pine Hill, A-2, Prairie, A-3, and Rice Branch, A-4 (see Figures 2-3, Appendix C). Forest and agriculture were the predominant LU/LC types of the Middle and Upper Tallapoosa River basins. Forest LU/LC was composed of a mosaic of clearcut areas, replanted areas, and areas of trees (mostly loblolly pine) at various stages of maturity. Agricultural LU/LC was composed of some forest, plus pasturelands (33-54% of the watershed) that receive manure from cattle grazing on them and from nearby poultry houses. Two point sources, the Dadeville Wastewater Treatment Plant (PS-1) and the Lafayette WWTP (PS-2), were also sampled to measure nutrients generated from these two communities. Eric Reutebuch, Wendy Seesock, David Bayne and graduate students sampled watershed sites for nutrients (TN, TP, SRP), TSS and discharge following *Standard Methods* protocols on the following dates: January 6, February 15, 21 (rain event) and 24 (rain event), March 8 (rain event) and16, April 7 (rain event) and 12, May 11 and 31 (rain event), June 9, July 7 (rain event), 11 (rain event) and 27, August 30, September 29, October 19, November 9 and 29 (rain event), and December 7, 2005.

Measuring discharge of Pine Hill Creek

Collecting water from the Tallapoosa River

2. Gage Data Downloading.

Eric Reutebuch downloaded gage data from all stream gages and performed gage maintenance on January 27, April 20 and October 31. Preliminary work began on developing hydrographs for gaged streams.

3. Lake Sampling.

Lake sampling was conducted at 14 sites on Lake Wedowee during the growing season (April-October, see table below, and Figure 6, Appendix C for map).

Station	Location		Lat	Lon
1	Harris Dam Forebay	Mainstem	33.2601	-85.6168
2	Confluence of Ginhouse, Lane and Miles Branch (GLM)	Embayment	33.2688	-85.5856
3	Mainstem off of Flat Rock Park	Mainstem	33.2851	-85.6250
4	Fox Creek	Embayment	33.3028	-85.6310
5	Mainstem downstream of Whispering Pines	Mainstem	33.3011	-85.6066
6	Triplett Creek	Embayment	33.3019	-85.5749
7	Mainstem at Hwy 48 bridge	Mainstem	33.3078	-85.5731
8	Mainstem Tallapoosa River above Indian Creek (T)	Mainstem	33.3448	-85.5964
9	Mainstem Little Tallapoosa River ~ 1 mile above Hwy 48 bridge (LT)	Mainstem	33.3180	-85.5655
10	Allen Creek	Embayment	33.3238	-85.5542
11	Mainstem of Little Tallapoosa River between river mile 14 and 15 (LT)	Mainstem	33.3333	-85.5504
12	Wedowee Creek	Embayment	33.3353	-85.5053
13	Pineywood Creek	Embayment	33.3616	-85.5032
14	Mainstem Little Tallapoosa River above Hwy 431 bridge (LT)	Mainstem	33.3606	-85.4874

David Bayne, Wendy Seesock, Eric Reutebuch and graduate students sampled 14 sites on Lake Wedowee for chlorophyll a, TN, TP SRP, TSS, pH, alkalinity, hardness, turbidity, conductivity, water temperature, dissolved oxygen, Secchi disk visibility and Forel-Ule color following *Standard Methods* protocols on April 18, May 18, June 20, July 25, August 24, September 27 and October 27, 2005. Two water samples were collected at each site for water chemistry analyses, one as a composite of the photic zone (determined by a submersed photometer) and the other collected at a discrete depth of 0.5 meters. The sampling dates were coincident with LWPOA water quality monitoring, UA hyperspectral sampling and Landsat satellite flyovers.

Water sample collection and in-situ measurements on Lake Wedowee

Water quality analysis in the lab at Auburn University

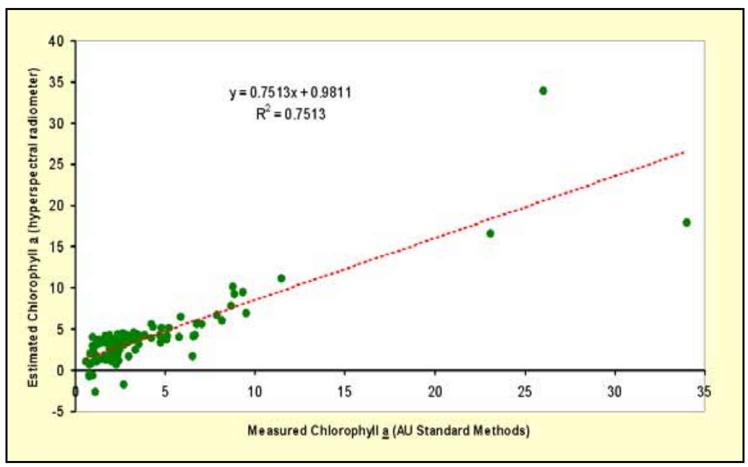
• **University of Alabama Research**

The field and laboratory methods performed by the University of Alabama team are referred to as 'high-tech' methods in this report. High-tech methods include 1) the use of a hyperspectral radiometer, the ASD FieldSpec UV/VNIR, to measure hyperspectral reflectance from lake surface waters, 2) the employment of modeling to generate whole-lake maps of water quality variables from field-sampled *Standard Methods* and hyperspectral data, and 3) the employment of GIS modeling to generate land use/land cover (LU/LC) datasets, as well as to generate estimates of nutrient and sediment loads from watersheds of varying LU/LC types.

1. Hyperspectral Remote Sensing Data Collection.

Luoheng Han conducted hyperspectral remote sensing data collection concurrent with the AU and LWPOA sampling on above-mentioned dates on Lake Wedowee. Charles Smith and Jack Duncan of LWPOA provided boat transportation for the remote sensing data collection. The high-end close range hyperspectral sensor used in this effort was the ASD FieldSpec UV/VNIR. All hyperspectral reflectance data were processed. The relationship between spectral reflectance and major water quality parameters, such as chlorophyll a, TSS, and Secchi disk visibility were analyzed.

Measuring spectral reflectance from the surface of Lake Wedowee



Regression line of estimated chlorophyll a from hyperspectral measurements versus chlorophyll a concentrations measured by Standard Methods (AU) in Lake Wedowee in 2005

2. Satellite Remote Sensing.

Luoheng Han acquired Landsat TM images to 1) derive current LU/LC information for GIS modeling of nutrients and water quality, and to 2) map water quality of Lake Wedowee, e.g., chlorophyll a concentration. Two cloud-free Landsat 5 TM images were acquired, one from April 18 and the other from June 23, 2005. The digital numbers were converted to reflectance values through radiometric correction procedures. A chlorophyll a map for Lake Wedowee was derived from the April 18th image. A supervised LU/LC classification was preformed using the September 22nd Landsat image. The LU/LC classes include: urban, agricultural land, pasture, disturbed land, evergreen forest, mixed forest, water, and wetland. A field trip to ground truth the LU/LC classification was conducted on October 22, 2004.

3. GIS Modeling.

The *Soil and Water Assessment Tool* (SWAT) model was used in a GIS platform to predict nutrient (phosphorus, nitrogen) and sediment load estimates for all subwatersheds of the Middle and Upper Tallapoosa basins. Input layers to the model included LU/LC (derived from Landsat 5 TM imagery), soils and climate data.

• Alabama Department of Environmental Management Research

The Alabama Department of Environmental Management (ADEM) is the state agency in Alabama that routinely samples the state's streams, rivers and lakes following *Standard Methods* protocols. During 2005, ADEM performed sampling in both the Middle and Upper Tallapoosa basins (on both lakes Martin and Wedowee).

1. Lake Martin Sampling.

ADEM sampled water quality monthly, April-October at 11 sites on Lake Martin following *Standard Methods* protocols (see Figure 13, Appendix C for map). Photic zone composite samples were collected and analyzed at all 11 sites. Additional water samples were collected at a discrete depth of 0.5 meters at six sites for chlorophyll a, turbidity and TSS measurements for correlation with coincident TWP remote sensing data collected by LWLM.

ADEM water sampling on Lake Martin

2. Lake Wedowee Sampling.

ADEM sampled water quality monthly, April-October at six sites on Lake Wedowee following *Standard Methods* protocols (see Figure 15, Appendix C for map). Samples were collected as a photic zone composite.

• Alabama Water Watch Research

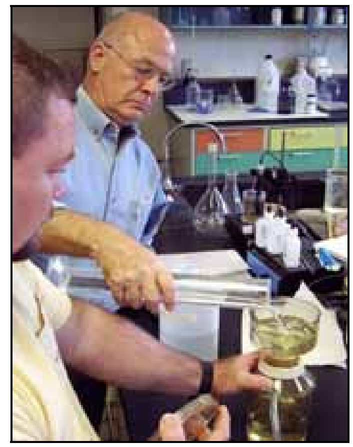
Field and laboratory methods employed by citizen volunteers of two local water monitoring groups, Lake Watch of Lake Martin (LWLM) and Lake Wedowee Property Owners Association (LWPOA), are referred to as 'low-tech' methods in this report. Low-tech methods include *in situ* testing of six-parameters (alkalinity, hardness, pH, turbidity, dissolved oxygen and water temperature) using a LaMotte model # 9844-01 water test kit. Volunteer monitors are certified in water chemistry testing by Alabama Water Watch (AWW) trainers following EPA-approved protocols developed by the AWW Program. Volunteers also routinely measure visibility of lake waters with a Secchi disk. More advanced 'low-tech' methods are being developed and tested by LWLM citizen volunteers, including 1) TSS sampling, 2) hyperspectral analyses of lake surface waters with a low-cost field spectrometer, and 3) chromaticity values.

1. <u>Lake Martin Sampling</u>.

The Lake Watch of Lake Martin (LWLM) team sampled water quality monthly, April-October, at five sites on Lake Martin, coincident with ADEM *Standard Methods* sampling, using the AWW test kit, hyperspectral analyses of lake surface waters with a relatively low-cost StellarNet EPP2000C spectrometer, chromaticity values (using StellarNet, a laboratory spectrophotometer and a digital camera) and TSS (see Figure 16, Appendix C for map). Water samples were processed for TSS at the Alexander City Sugar Creek Wastewater Treatment Plant Laboratory in partnership with the city.

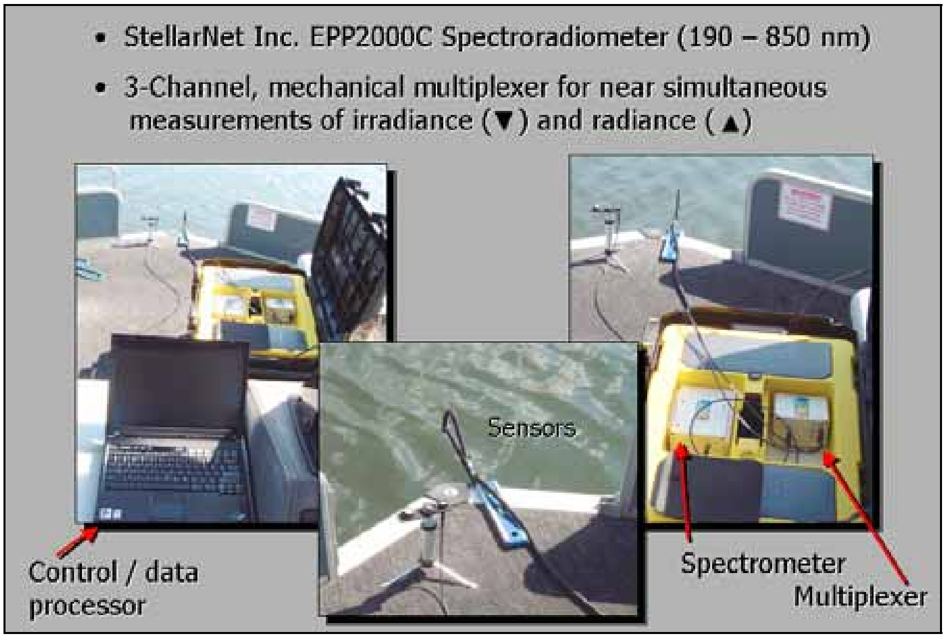
Measuring DO with the AWW test kit

Measuring spectral reflectance from the surface of Lake Martin



Filtering water sample for TSS measurements

During 2005, John Glasier from LWLM continued to refine the lake sampling protocol and improve system performance for *in situ* hyperspectral reflectance measurements and chlorophyll <u>a</u> spectral signature analysis using the StellarNet EPP2000C spectroradiometer and Spectra Wiz software from StellarNet, Inc. Results from lake monitoring during 2004 indicated that a dual-head sensor configuration, which simultaneously measures downwelling irradiance and upwelling radiance from the water's surface, would substantially improve overall system performance. Simultaneous measurement of these two reflectance components with fiber optic heads dedicated to each radiation source addresses two major concerns regarding measurement accuracy and precision: 1) movement of a single sensor head to accommodate both measurements, and 2) dwell time between downwelling and upwelling measurements, especially under changing cloud-cover conditions. With only one sensor head for measuring both components of reflectance, the head must be reoriented by hand to facilitate each measurement to include reflectance calibration with a reference standard. This reorientation and delay between measurements contributes to measurement error. In February 2005, Mr. Glasier met with StellarNet applications scientists at their manufacturing facility in Tampa, Florida to discuss possible modifications to LWLM's existing spectrometer systems. StellarNet designed and manufactured a small, 3-channel fiber optic multiplexer together with needed application software enhancements for a dual-head system (see picture below). This system was tested during the September and October 2005 sampling dates on Lake Martin and side-by-side sampling with University of Alabama's high-end ASD spectrometer on Lake Wedowee in September 2005. Measurement results indicate that the dual-head capability is a significant enhancement. Additional side-by-side system comparisons are planned for during the 2006 growing season on Lake Martin.



StellarNet 'Dual-Head' Spectroradiometer

2. Lake Wedowee Sampling.

The Lake Wedowee Property Owners Association (LWPOA) provided boat transportation for the UA remote sensing team, and also sampled monthly April-October coincident with AU, UA and the Alabama Department of Environmental Management sampling using the AWW test kit for six physicochemical parameters, and Secchi disk measurements (see Figure 19, Appendix C for map).

Measuring Secchi disk visibility on Lake Wedowee

Students take a voyage into environmental education on Lake Wedowee

- **Preliminary Research Results**
  (See Appendix C, Figures 1-20)

Analyses of Year 2 (2005) research data are ongoing; therefore the following results are preliminary. All Year 2 objectives were accomplished. All lake fieldwork was conducted within one day of the Landsat satellite flyover, except for the May, July and September outings (which were within two days of the flyover) to maximize relationships between satellite imagery and optically active constituents (chlorophyll a, TSS, Secchi disk visibility) of lake water. Data has been received from the Alabama Department of Environmental Management, and will be included in ongoing analyses.

1. Standard Methods – Auburn University Research

   A. Watershed Sampling, (Figures 1-3, maps; 4-5, results)

      1) Hydrographs from stream gages indicated that stream flow was highly variable (flashy), and that for rain event sampling, water samples should be collected within 6-12 hours after the onset of a rainfall/runoff event to measure nonpoint source nutrient and sediment loading.

      2) During regular monthly sampling, agricultural streams were 5.5 times greater in TN, 3.4 times greater in TP and 1.4 times greater in TSS concentrations than silvicultural streams, on average (21 sample dates from 2/2004-10/2005, Figure 4).

      3) During rain event sampling, agricultural streams were 5.8 times greater in TN, 6.7 times greater in TP and 3.2 times greater in TSS concentrations than silvicultural streams, on average (10 sample dates from 2/2004-10/2005, Figure 5).

      4) In silvicultural watersheds, average TN concentrations increased by a factor of 1.6 (from 212 μg/L to 335 μg/L), TP concentrations increased by a factor of 2.6 (from 10 μg/L to 26 μg/L), and TSS increased by a factor of 3.4 (from 3.2 mg/L to 10.9 mg/L) during rain events (Figures 4-5).

      5) Silvicultural streams were low in nutrient (TN and TP) concentrations during regular and rain event sampling, well below the 100 μg/L TP level recommended as a maximum for flowing streams (EPA 1986), and well below the 1000 μg/L TN stated as an upper limit for unpolluted natural waters (Boyd 1988). Silvicultural streams were also relatively low in TSS.

      6) Agricultural streams were much higher in nutrient (TN and TP) concentrations during regular and rain event sampling, oftentimes above the 100 μg/L TP level recommended as a maximum for flowing streams (EPA 1986) during rain events, and oftentimes above the 1000 μg/L TN stated as an upper limit for unpolluted natural waters (Boyd 1988) during both rain event and regular sampling. During rain events, agricultural streams were also relatively high in TSS.

7) In agricultural watersheds, average TN concentrations increased by a factor of 1.7 (from 1,158 μg/L to 1,944 μg/L), TP concentrations increased by a factor of 5.1 (from 34 μg/L to 173 μg/L), and TSS increased by a factor of 7.8 (from 4.5 mg/L to 35.2 mg/L) during rain events relative to regular monthly sampling (Figures 4-5).

8) The silvicultural stream with active clear cutting in the watershed (site F-2) had two times greater average TSS concentration than the silvicultural stream without clear cutting (site F-1) during rain event sampling relative to regular monthly sampling (Figures 4-5).

9) Preliminary correlation analyses indicated that in the six small watersheds that were gaged and sampled for water chemistry, TSS, TP and total alkalinity were significantly correlated (R = 0.38, 0.15, -0.26 respectively) to stream discharge. TSS was positively correlated to TP, soluble reactive phosphorus and total alkalinity (R = 0.65, 0.52, 0.16 respectively).

B. <u>Lake Sampling (Figures 6,map; 7-8, results)</u>

1) Nutrient (TP), and Secchi disk visibility results indicated that the lower end of Lake Wedowee (near the dam) was mesotrophic, the middle section of the lake transitioned from mesotrophic to eutrophic, and the upper section of the lake was eutrophic. Of the six embayments sampled, Piney Creek, Wedowee Creek and Fox Creek were the most enriched, in the eutrophic range, while Allen, Triplet and GLM (confluence of Ginhouse Branch, Lane Branch and Miles Branch) were less enriched, in the mesotrophic range. TP concentrations measured at a depth of 0.5 meters agreed closely with that measured from photic zone composite samples (data from 4-10/2005, Figure 7).

2) According to chlorophyll <u>a</u> (corrected) results, Lake Wedowee was eutrophic from the dam to the most upstream sample site (site 14), but the lower end of the lake was lower eutrophic (average of 8.6 μg/L chlorophyll <u>a</u>) whereas the upper section of the lake was mid-range eutrophic (average of 14.1 μg/L chlorophyll <u>a</u>, data from 4-10/2004, Figure 7).

3) The Tallapoosa River system drops significantly in both TP (growing season average of 50.1 down to 5.0 μg/L) and chlorophyll <u>a</u> (growing season average of 14.1 down to 1.3 μg/L) from the upper end of Lake Wedowee (AU site 14) downstream about 100 river-miles to the lower end of Lake Martin (AU site 4, near Martin Dam). It appears that both lakes Wedowee and Martin are acting as significant nutrient (TP) sinks and waters downstream of both lakes are 'cleaner' or less productive in terms of trophic state and nutrient concentrations. Lake trophic state dropped from eutrophic at the uppermost site (Wedowee - AU site 14) to oligotrophic at the lowermost site (Martin - AU site 4). The trend in Secchi disk visibility was inverse to that of TP and chlorophyll <u>a</u>, as expected, increasing from a low of 1.1 meters (growing season average) at the upper end of Lake Wedowee (AU site 14) to a high of 5.2 meters downstream at the lower end of Lake Martin (AU site 4, see Figure 8).

2. High-Tech – University of Alabama Research

A. Lake Sampling (Figures 9-11)

1) Two relatively cloud-free Landsat TM images were acquired for the 2005 growing season (April 18th and June 23rd). The other five sampling dates yielded cloudy imagery. A color-coded chlorophyll a map for Lake Wedowee was derived from the April Landsat image, and another chlorophyll a map for Lake Martin was produced for September, 2004 (see Figures 9 and 10). Color-coding of the chlorophyll map generally agreed with *in situ* chlorophyll readings. Refinements to the modeling are ongoing.

2) Analysis of the relationship between hyperspectral reflectance, using the ASD FieldSpec UV/VNIR close range hyperspectral sensor, and optically active water quality parameters (chlorophyll a, TSS, Secchi disk visibility) of Lake Martin water (2004 data, n = 106 readings) yielded significant regressions (see Figure 11). The regression line predicting TSS from hyperspectral reflectance (first derivative of reflectance at 725 nanometers) had a negative slope ($R^2 = 0.91$). The regression line predicting Secchi disk visibility from hyperspectral reflectance (first derivative of reflectance at 510 nanometers) had a negative slope ($R^2 = 0.71$). The regression line predicting chlorophyll from hyperspectral reflectance (first derivative of reflectance at 685 nanometers) had a positive slope ($R^2 = 0.75$). Further analyses are ongoing.

B. Watershed Modeling (Figure 12)

1) A 2005 land use/land cover (LU/LC) map containing seven LU/LC classes was successfully generated for the Middle and Upper Tallapoosa River basins from Landsat satellite imagery, for use in GIS modeling.

2) The SWAT model was used in a GIS platform to generate estimates of nutrient and sediment loading from all subwatersheds in the Middle and Upper Tallapoosa basins. Preliminary estimates of total phosphorus ranged from about 170 to over 11,000 kilograms TP/subwatershed/month for April 2005 (see Figure 12).

3. Standard Methods – ADEM Research

A. Lake Sampling (Figures 13, map; 14, results)

Comparison of the growing season average of five sites on Lake Martin sample in 2004-2005 indicated that three of five sites (18, 20 and 24 – AU site codes) were eutrophic in 2004 and all five sites were eutrophic in 2005 (sites 10, 24 and 25 were marginally eutrophic, Figure 14). Coley Creek Embayment (AU site 20) was the most enriched site both years with growing season average chlorophyll a concentrations of 18.5 and 16.6 μg/L in 2004 and 2005 respectively.

4. Low-Tech – Lake Watch of Lake Martin (LWLM) Research

A. LWLM Water Chemistry Monitoring (Figures 16, map; 17, results)

The LWLM citizen monitors tested at 14 active sites, 13 of which were on Lake Martin, in 2005. Following are conclusions of LWLM testing at five sites (see Figure 16) during the

2004 and 2005 growing seasons (April-October). All comparisons are of growing season averages (7 observations per average).

1) Of the five sites monitored by LWLM for water chemistry, Coley Creek Embayment (site 20) had the highest turbidity both years, while three downstream sites (11, 14, 18) all had low turbidity (sites 11, 14, 18; see Figure 17, sites labeled with AU site codes).

2) The mainstem Tallapoosa River site above Coley Creek (site 25) had the highest TSS both years, while the mainstem site at Bay Pine Island (site 14) had the lowest (see Figure 17).

3) The mainstem Tallapoosa River site above Coley Creek (site 25) and the Coley Creek site (20) had the lowest Secchi disk visibility both years (1.1-1.8 meters), while the mainstem site at Bay Pine Island (site 14) had the highest (2.7-3.1 meters; see Figure 17).

4) The use of a view-scope during Secchi disk visibility measurements was found to minimize surface-water glare and turbulence, and provide more accurate measurements.

B. LWLM Hyperspectral Sampling Compared to the ASD FieldSpec UV/VNIR (Figure 18)

Preliminary analysis of side-by-side measurements of the relatively low-cost LWLM spectrometer (StellarNet EPP2000C) and the high-end spectrometer used by the University of Alabama (ASD FieldSpec UV/VNIR) indicated that the StellarNet performed well (R^2 of side-by-side measurements in September 2004 at site 20 on Lake Martin was 0.987, see Figure 18) and has potential for monitoring chlorophyll in Alabama lakes. Data analyses are ongoing.

5. Low-Tech – Lake Wedowee Property Owners Association (LWPOA) Research

A. LWPOA Water Chemistry Monitoring (Figures 19, map; 20, results)

The LWPOA citizen monitors tested at 12 active sites, 10 of which were on Lake Wedowee, in 2005 (see Figure 19). Four of the citizen monitoring sites were coincident with the 2005 AU Standard Methods sites: LWPOA site 07004017 (AU site 6), LWPOA site 07004020 (AU site 10), LWPOA site 07004016 (AU site 11), and LWPOA site 07004018 (AU site 14). Following are conclusions of coincident monitoring on Lake Wedowee during the 2005 growing season (April-October). All comparisons are of growing season averages (7 observations per average).

1) Growing season average pH measured by AU and LWPOA differed by 0.54 pH units, on average, across the four sites (see Figure 20). LWPOA values were slightly higher than those of AU. All sites averaged near neutral pH (pH=7).

2) Growing season average total alkalinity measured by AU and LWPOA differed by 10.4 mg/L (equal to about 2 drops in the citizen test procedure), on average, across the four sites (see Figure 20). LWPOA values were consistently higher than those of AU. All sites had relatively ‘soft’, poorly buffered waters.

3) Growing season average dissolved oxygen (DO) measured by AU and LWPOA differed by 0.45 mg/L, on average, across the four sites (see Figure 20). All DO values were 6 mg/L or higher, well above the 5 mg/L ADEM minimum required for Fish and Wildlife-classified waters, like Lake Wedowee.

4) Growing season average Secchi disk visibility measured by AU and LWPOA differed by 0.59 meters, on average, across the four sites (see Figure 20). LWPOA values were consistently lower than those of AU. This was most likely because of glare at the water's surface interfering with the LWPOA measurements (AU researchers use a glass-bottom bucket to minimize glare while measuring Secchi visibility).

V. EDUCATION/EXTENSION

• Education and Extension Team Meetings

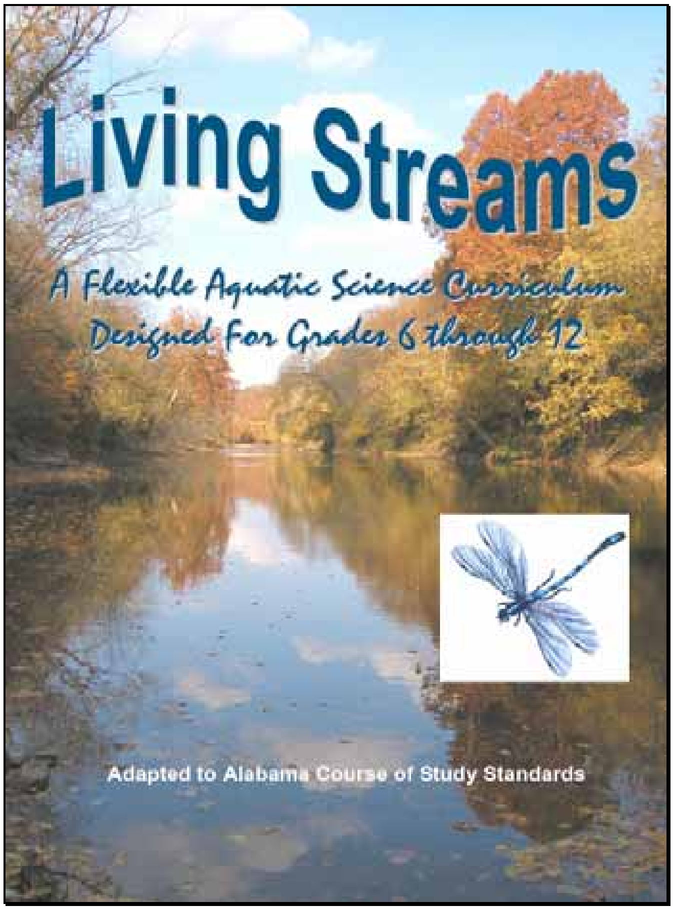
1. Education/Extension Meeting: April 12, 2005. Camp ASCCA, Jacksons Gap, AL.

Participants discussed new/potential activities of the Education/Extension team and reallocation of the TWP budget as needed. The following budget was agreed upon for a portion of the remaining $48,000 in the Education/Extension budget for the next 17 months (until Sep 06): 1) two TWP *State of Our Watershed* Conferences - $9000 at $4,500 each, 2) curricula development (extension of the AUEI project) - $9,000, and 3) TWP video or DVD (perhaps supplemented with ACES funds) - $5,000. Possibilities for the remaining $17,000 (to be discussed at later meetings) included: fund school groups to come to ASCCA for learning about TWP, website development (example - Tallapoosa Jeopardy Game online), TWP brochures and reports, journal publication costs for TWP articles, registration at professional meetings to give TWP papers, dataviewer development for linking CWP/TWP/ AWW data, satellite displays of the Tallapoosa Watershed, supplements to developing environmental education curriculum, printing of *Living Streams* and other curricula materials.

• Curriculum Development

1. Development of *Living Streams* Curriculum

Living Streams is a weeklong curriculum developed for secondary education in Alabama public schools, through funding from the Auburn University Environmental Institute and the Tallapoosa Watershed Project, by Alabama Water Watch (AWW) and the Department of Curriculum and Teaching at Auburn University. The *Living Streams* curriculum is based on AWW stream biomonitoring protocols, which have been adapted to meet Alabama State Department of Education Course of Study standards. AWW certifies schoolteachers and university interns in stream biomonitoring, which involves collecting macroinvertebrates (aquatic insects, aquatic worms, snails and crayfish) from a stream and evaluating stream health based on the presence and/or absence of aquatic insect species. *Living Streams* offers teachers a flexible guide for teaching basic aquatic science principals and the effects of nonpoint source pollution on streams, rivers, and lakes. The curriculum links teachers with university interns in science education and local AWW citizen volunteer monitors, both of whom provide assistance in implementing the curriculum. *Living Streams* serves as a tool to raise conservation awareness in the classroom, as well as in local communities, by strengthening local partnerships among citizens interested in the protection and restoration of Alabama's water resources.



The Living Streams aquatic science curriculum manual

AWW training university interns in collection of aquatic insects for stream bioassessment

Sixth graders and international trainees of Global Water Watch learning about Living Streams at Timbergut Creek in the Tallapoosa Basin

2. <u>Piloting the *Living Streams* curriculum in four local public schools: Spring 2005.</u>

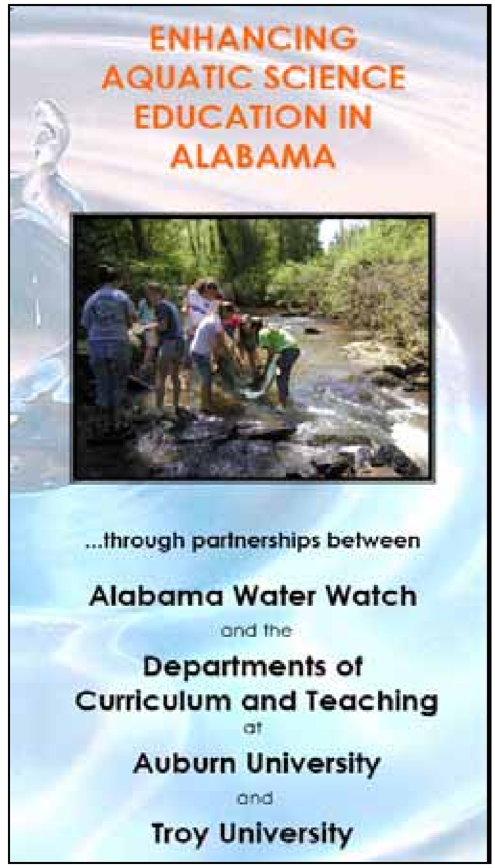
Living Streams curriculum was piloted by Summer Williams and Jacque Middleton at Drake Middle School (Auburn), Stan Arrington and Marilyn Taylor at Auburn High School, Fletcher Scott and Laurie Mirarchi at Benjamin Russell High School (Alexander City), and Angie Kelley and Brandon Kiser at Opelika High School. AWW citizen monitors of the Lake Watch Lake Martin and Save Our Saugahatchee (SOS) met teachers and students at stream sites over a two-day period to assist in the macroinvertebrate sampling portion of *Living Streams*. A questionnaire was developed by Charles Eick and Jacque Middleton to assess the *Living Streams* curriculum. The questionnaire was given to teachers and AWW monitors piloting the curriculum. Jacque Middleton collected and collated the teacher responses concerning the *Living Streams* curriculum. Jacque Middleton and Jennifer Fuller met to discuss the curriculum comments and suggestions. Jennifer will revise the *Living Streams* curriculum for use in a second round pilot project in 2006.

3. Student Workshop: May 20, 2005. Auburn, AL. Bill Deutsch, David Newton, Charles Mitchell and Gene Hunter taught stream sampling techniques to about 45 sixth-grade students from Drake Middle School, Auburn. Bill taught stream biomonitoring and David, Charles and Gene (SOS members) taught water chemistry monitor.

4. Aquatic Science Education Brochure. Aug. 2005. A brochure describing the AWW partnership with AU Department of Curriculum and Teaching for the advancement of aquatic science education was developed for distribution to teachers and the general public.

5. Teacher Workshop: Sept. 28, 2005. Auburn, AL. Sergio Ruiz-Cordova and Shelley England (AWW staff) conducted a workshop for 10 of Dr. Charles Eick's students on how to bring science into the classroom through AWW.

6. Revision of *Living Streams*. December 2005. The Living Steams curriculum manual was revised, based on survey results and comments from participants in the 2005 pilot project, and was sent to the printer for printing.



Brochure describing the Living Streams curriculum

• Community Outreach

1. State of Our Watershed Conference: May 5-6, 2005. Camp ASCCA, Jacksons Gap, AL.

The First Annual *State of Our Watershed Conference – The Tallapoosa River Basin* was held at Camp ASCCA (Alabama's Special Camp for Children and Adults), Jacksons Gap, AL (go to *www.twp.auburn.edu/ExtSOWconf.aspx* for full agenda, presentations and photos). The first day of the conference summarized TWP research, as well as that of other local, state and federal agencies, and its applications to management of the Tallapoosa River Basin. On the second day, TWP education and outreach activities were shared with 13 local teachers and more than 50 students. Outdoor activities included stream biomonitoring (collection of stream insects to determine stream health), construction of a rain garden at Camp ASCCA, a tour of Camp ASCCA and its Environmental Center, a demonstration model of lake stratification and its implications to lake water quality, and a boat ride on Lake Martin to measure lake clarity using a Secchi disk. Attendance for the conference was about 140 people.

State of Our Watershed Conference, May 5-6, 2005

VI. RELATED PROJECTS

• Alabama Cooperative Extension System (ACES) Programs

The TWP collaborated with the ACES Tallapoosa County Coordinator, Tommy Futral, in the integration of the *Living Streams* program into the existing ACES *Classroom in the Forest* program. The *Living Streams* program targets 5th grade students, and introduces them to several aspects of the TWP. The *Living Streams* Program gives students a hands-on learning experience as they explore the macroinvertebrates that live in streams. Students learn to identify different species of macroinvertebrates by getting into a stream and collecting them from under rocks, leaves and aquatic plants. After tallying the number of different species in three different groups (see Figure 21, AWW's Bio-Assess Stream Quality Assessment Form, in Appendix C), they can rank the stream water quality as excellent, good or poor. Students learn that trees play an important role in water quality by holding the soil, providing shade and slowing the flow of runoff from rain events.

Enviroscape is a model of a watershed that is used to show students how pollution impacts the water that a community uses for drinking, swimming, fishing and boating. The model has streams and a lake, forests, factories, farms, subdivisions, a golf course, a sewage treatment plant and roads with cars. Kool-Aid of different colors is used to simulate pollutant runoff from each of the different land-use areas. Students are taught how they can help keep their streams, rivers and lakes clean.

ACES county coordinator and TWP collaborator Tommy Futral teaches students about watershed management using the Enviroscape model

TWP, MTRBCWP, ACES, Alexander City officials and Radney Elementary School team up in stream bank restoration

1. *Classroom in the Forest* Program: April 28, 2005. Camp Hill, AL.

Tommy Futral, Bob Daniel, Brian Osborn, Jerry Brown and Tammy Jones conducted the *Classroom in the Forest* program for 110 5th grade students from Dadeville Elementary School.

2. *Classroom in the Forest* Program: April 29, 2005. Camp Hill, AL.

Tommy Futral, Tammy Jones, James Yarbrough, Kelvin Perkins and Allen Williams conducted the *Classroom in the Forest* program for 120 5th grade students from Edward Bell and Reeltown elementary schools.

3. *Classroom in the Forest* Program: May 3, 2005. Hackneyville, AL.

Tommy Futral, David Kelly, Fred Wilhelm, Shane Harris and Danny Baker conducted *Classroom in the Forest* for 296 5th grade students from Radney School.

4. *Classroom in the Forest* Program: May 5, 2005. Hackneyville, AL.

Tommy Futral, Allen Williams, Brian Osborn, Bob Daniel and Rita Brown conducted *Classroom in the Forest* for 85 5th grade students from Horseshoe Bend School.

5. *Enviroscape*: August 14, 2005. Alexander City, AL.

Tommy Futral conducted a program for 160 3rd and 4th grade students at Stephens Elementary School using the *Enviroscape* watershed model. Ann Goree trained and presented the program to 480 students at the same school.

6. *Enviroscape*: August 21, 2005. New Site, AL.

Tommy Futral Conducted a program for 83 5th grade students at Horseshoe Bend Elementary School using the *Enviroscape* watershed model.

7. *Classroom in the Forest Program*: September 29, 2005. Dadeville, AL.
Tommy Futral, Bob Daniel and Tammy Jones conducted *Classroom in the Forest* for 135 5th grade students at Council School.

8. Stream Restoration Project: November 14, 2005. Alexander City, AL.
Tommy Futral and Eve Brantley (ACES), the mayor and city employees, and members of the Middle Tallapoosa River Basin Clean Water Partnership teamed up with 15 students and two teachers from Radney Elementary School to plant trees, shrubs, grass, and flowers to stabilize the banks of a local stream. They also established a pocket wetland.

9. *Enviroscape*: November 22, 2005. Alexander City, AL.
Tommy Futral Conducted a program for 165 1st and 2^{cnd} grade students at Jim Pearson Elementary School using the *Enviroscape* watershed model. Martha White trained and presented the program to 490 students at the same school.

• Stream Bioassessment using Fish and Macroinvertebrate Communities

The Middle Tallapoosa River Basin Clean Water Partnership (MTRBCWP) and the Lake Wedowee Property Owners Association (LWPOA) responded to a proposal from the AU Fisheries Department for funding stream bioassessment by examination of fish communities in select streams of the Upper and Middle Tallapoosa River basins ($7,500 provided by the MTRBCWP and $500 by LWPOA). Stream bioassessment by the examination of macroinvertebrate communities (aquatic insects and worms, snails, and crayfish) was also conducted on the same streams (except for Mill Creek). Funding for stream macroinvertebrate sampling was provided by the MTRBCWP ($6,000) and the AU Environmental Institute ($3,000) in 2004.

Sampling fish in Rice Branch in December, 2005

AU Fisheries biologists identifying, weighing and measuring fish for determination of stream IBI score

1. <u>Stream bioassessment by the examination of fish communities</u>.

Fish communities were sampled in seven streams that had been sampled for water quality and aquatic insects as part of the TWP: from the two forested streams (Birdsong and Jones creeks), the four agricultural streams (Grants Branch, Pine Hill, Prairie and Rice Branch) and one urban stream (Mill Creek, downstream of the point source sample site, PS-2, the Lafayette city wastewater treatment plant). Fish were collected in each stream by sampling a 100-meter stream segment using a backpack shocker (Karr 1981; Angermeir and Karr 1986; O'Neil and Shepard 1998). Fish were identified, weighed and measured and the data will be used to calculate an Index of Biotic Integrity (IBI) score for each stream. This score will indicate stream health when compared to a relatively undisturbed reference stream.

Some of the fish species found in small streams of the Tallapoosa River Basin: 1 – Alabama Hogsucker, 2- Mottled Sculpin, 3 – Blacktail Shiner, 4 – Black Madtom, 5 – Tallapoosa Darter.

A total of 1,489 fish representing 7 families and 30 species were collected. Dominant species included: largescale stoneroller (*Campostoma oligolepis*); Tallapoosa shiner (*Cyprinella gibbsi*); mottled sculpin (*Cottus bairdii*); creek chub (*Semotilus atromaculatus*); Tallapoosa darter (*Etheostoma tallapoosae*); bluegill sunfish (*Lepomis macrochirus*); Alabama hogsucker (*Hypentelium etowanum*); and bluehead chub (*Nocomis leptocephalus*); which accounted for about 84 % of the fish sampled. Highest diversity (number of species) of fish was sampled in the agricultural stream A-1, Grants Branch, which had 19 different fish species (see table below). Lowest diversity was found in the urban stream, Mill Creek (sampled directly downstream of the outfall of Lafayette wastewater treatment plant), which had only 4 species. The other five streams had species numbers between 12-15. The average number of species by land use type was 14.0 for forested streams, 14.8 for agricultural streams, and 4 for the urban stream.

Scientific Name	Common Name	F-1* Birdsong Creek	F-2 Jones Creek	A-1 Grants Branch	A-2 Pine Hill	A-3 Prairie Creek	A-4 Rice Branch	PS-2 Mill Creek
Ambloplites ariommus	Shadow Bass				X			
Ameiurus natalis	Yellow Bullhead				X			
Campostoma oligolepis	Largescale Stoneroller	X	X	X	X	X	X	
Cottus bairdii	Mottled Sculpin	X	X	X	X	X	X	
Cyprinella gibbsi	Tallapoosa Shiner	X	X	X		X	X	
Cyprinella venusta	Blacktail Shiner		X	X			X	
Etheostoma tallapoosae	Tallapoosa Darter	X	X	X	X	X	X	X
Fundulus bifax	Stippled Studfish	X						
Fundulus olivaceus	Blackspotted Topminnow			X			X	
Hybopsis lineapunctata	Lined Chub	X	X					
Hypentelium etowanum	Alabama Hogsucker	X	X	X	X	X	X	X
Ichthymoyzon gagei	Southern Brook Lamprey	X						
Lepomis auritus	Redbreast Sunfish	X		X		X	X	X
Lepomis cyanellus	Green Sunfish			X	X	X	X	
Lepomis macrochirus	Bluegill Sunfish		X	X	X	X	X	
Lepomis megalotis	Longear Sunfish				X			
Luxilus chrysocephalus	Striped Shiner	X	X					
Luxilus zonistius	Bandfin Shiner			X		X	X	
Micropterus coosae	Redeye Bass	X	X					
Micropterus punctulatus	Spotted Bass					X		
Micropterus salmoides	Largemouth Bass			X				
Nocomis leptocephalus	Bluehead Chub	X	X	X	X	X	X	
Notropis baileyi	Rough Shiner	X		X				
Notropis buccatus	Silverjaw Minnow							X
Notropis texanus	Weed Shiner			X				
Noturus funebris	Black Madtom	X	X		X		X	
Percina kathae	Mobile Logperch			X				
Percina macrocephala	Muscadine Darter	X		X		X	X	
Percina palmaris	Bronze Darter			X				
Semotilus atromaculatus	Creek Chub		X	X	X	X	X	
Total number of species per stream		**15**	**13**	**19**	**12**	**13**	**15**	**4**
Average # of species per stream by Land Use		**14.0**		**14.8**				**4**

The most frequently occurring species were the Tallapoosa Darter (*Etheostoma tallapoosae*) and the Alabama Hogsucker (*Hypentelium etowanum*), which occurred in all seven streams. Three other species, the Largescale Stoneroller (*Campostoma oligolepis*), the Mottled Sculpin (*Cottus bairdii*) and the Bluehead Chub (*Nocomis leptocephalus*) were found in all streams except for the urban stream, Mill Creek. Based on abundance over all seven streams, the Largescale Stoneroller (*Campostoma oligolepis*) was the most abundant fish species (see Figure 22 in Appendix C).

2. <u>Stream bioassessment by the examination of macroinvertebrate communities.</u>

The six TWP streams that were gaged and sampled for nutrient and sediment loading were sampled by AU researcher, Cliff Webber, for macroinvertebrate community structure following a standard scientific method (Webber 2006) between November 2004 and January 2005. Two of the six streams, Birdsong and Jones creeks, were sampled by AWW-certified citizen volunteer monitors, Dick and Mary Ann Bronson and Dick Duncan, following the AWW bioassessment protocol. Goals of this project were: 1. to assess the health of the six sampled streams, and 2. to evaluate and refine AWW volunteer monitoring bioassessment techniques and protocols based on side-by-side results with AU sampling. All sample sites were in the Southern Inner Piedmont sub-ecoregion of the Piedmont Ecoregion, which is characterized by relatively infertile, poorly buffered soils and streams.

The biological condition of each stream was determined by Webber using a multi-metric approach (Plafkin et al. 1989). Calculated biological scores of each stream were compared to scores of Birdsong Creek, which was chosen as the reference stream for this study since it exhibited excellent water quality during the two years of this study. A total of 92 different aquatic taxa (most of which, 93%, were aquatic insects) were collected from the six streams. Grants Branch yielded the highest number of taxa, 55; whiled Pine Hill Creek had the lowest, 33 (see table below).

	Metric Value					
	Stream Sites					
	F-1*	F-2	A-1	A-2	A-3	A-4
Taxa Richness	43	42	55	33	36	46
EPT Index	17	17	24	11	12	17

*F-1 = Reference stream, Birdsong Creek was chosen as the reference site for this study.
F-2 = Jones, A-1 = Grants Branch, A-2 = Pine Hill, A-3 = Prairie, A-4 = Rice Branch.

Grants Branch also supported the highest number of EPT taxa (24), which are aquatic insects (Ephemeroptera-mayflies, Plecoptera-stoneflies and Trichoptera-caddisflies) that generally require high stream water quality and good stream habitat. Results of the multi-metric scoring, which combines taxa richness and five other biocriteria scores (Webber 2006), indicated that Pine Hill Creek was the only stream that exhibited slight impairment, while the other four streams scored as nonimpaired against the reference stream, Birdsong Creek. At the time of this study, the higher nutrient concentrations in the streams with agricultural activities on the watershed did not contribute to the degradation of macroinvertebrate communities, except for in Pine Hill Creek. Webber has observed in other studies in Piedmont watersheds with naturally low fertility that moderate increases in nutrient concentrations in a stream apparently contributed to increased diversity of macroinvertebrate taxa, including more sensitive EPT taxa.

Habitat assessments were also conducted at each of the six streams during field sampling. Stream habitat was scored on the basis of the presence and quality of bottom substrate, channel morphology and condition and features of the stream bank and riparian vegetation. Compared to Birdsong Creek (reference stream), the other five streams scored as follows (best to worst):

Grants Branch - >100 (excellent), Jones Creek – 99 (excellent), Rice Branch – 88 (good), Pine Hill – 74 (fair), and Prairie Creek – 67 (fair). Heavy deposition of sediment, the lack of substrate, and degradation of riparian vegetation were the primary variables that contributed to ranking Pine Hill and Prairie creeks as only partially supporting of healthy aquatic communities. However, habitat conditions in the other two agricultural streams, Grants Branch and Rice Branch, were supportive of healthy communities, as was Jones Creek, the other forested stream.

AU and AWW macroinvertebrate sampling in streams of the Tallapoosa River Basin.

Alabama Water Watch monitors identified macroinvertebrates in the field from riffles in Birdsong Creek and Jones Creek. In the laboratory Webber checked through these same riffle samples collected by the citizen monitors and identified additional macroinvertebrates. Using the AWW macroinvertebrate protocol the citizen monitors and Webber came up with the same bioassessment in Birdsong Creek, however, differences were found in Jones Creek. These differences reflected the experience from years of macroinvertebrate identification by Webber. The refinements ultimately needed to modify the existing AWW macroinvertebrate protocol so that it stands the scrutiny of a quality assurance plan will probably require some type of identification to at least the family level for selected macroinvertebrate representatives. Jennifer Fuller is working on refinement of the AWW stream bioassessment protocol.

• **Synergies with other USDA/CSREES Projects and Activities**

Synergies between the TWP and other USDA/CSREES projects are numerous and continue to evolve at the local, regional and national levels. Here are several that have developed through the second year of this project:

1. Collaboration with the Alabama Cooperative Extension System (ACES).

TWP continues to work with ACES county extension agents in integrating education/ outreach materials from the developing *Living Streams* curriculum into existing ACES programs such as *Classroom In The Forest*. Bill Deutsch, TWP Director, has a one-third appointment with ACES and co-directs an Extension Team Project in the area of Natural Resources.

2. Collaboration with USDA/CSREES Project No. ALA03-065.

TWP continues to work with another USDA/CSREES project, *Developing Community-Based Restoration Initiatives, through the Promotion of Education/ Outreach Activities that Promote Watershed Protection*. This project and the TWP collaborated on rain garden installations on school campuses.

Students installing a rain garden

3. Participation with the USDA/CSREES Southern Region Watershed Assessment Team.

Bill Deutsch, TWP Director, is the Auburn University participant on the Watershed Assessment Team. Bill attended the CSREES Southern Region Water Conference in Lexington, KY, where he presented a TWP-related paper (see page 11 and Appendix B) and met with the watershed assessment team.

4. Participation with the CSREES National Facilitation Project.

TWP personnel regularly interact with staff of the CSREES National Facilitation Project in Volunteer Water Monitoring. Bill Deutsch is scheduled to give a presentation entitled What Volunteer Monitoring has to Offer Municipal Officials…a Case from Alabama, as part of a National Facilitation Project symposium at the CSREES National Water Conference in San Antonio, TX, February 6, 2006, and will also present at the National Water Quality Monitoring Council's 2006 National Monitoring Conference in San Jose, California in May 2006.

5. Bill Deutsch submitted an abstract entitled Innovations in understanding basin-scale nutrient dynamics to the USDA CSREES National Water Conference, San Antonio, Texas, February 5-9, 2006 (see Appendix B).

VII. LITERATURE CITED

Angermeir, P. L. and J. R. Karr. 1986. Applying an Index of Biotic Integrity based on stream-fish communities: considerations in sampling and interpretation. North American Journal of Fisheries Management 6:418-429

APHA (American Public Health Association), American Water Works Association and Water Pollution Control Federation. 1998. Standard Methods for the Examination of Water and Wastewater. 20th edition. APHA, Washington, D.C.

Boyd, C. E. 1988. Water quality in warmwater fish ponds. Auburn University Agricultural Experiment Station, 359 pp.

EPA. 1986. Quality criteria for water – 1986. Publication number 440/5-86-001. U. S. EPA Office of Water Regulations and Standards, Washington DC 20460, 477 pp.

Karr, J. R. 1981. Assessment of biotic integrity using fish communities. Fisheries vol. 6 no. 6, 21-27.

O'Neil, P. E. and T. E. Shepard. 1998. Standard operating procedure manual for sampling freshwater fish communities and application of the Index of Biotic Integrity for assessing biological condition of flowing, wadeable streams in Alabama. Geological Survey of Alabama, 86 pp.

Plafkin, J. L., M. T. Barbour, K. D. Porter, S. K. Gross, and R. M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers. Benthic macroinvertebrates and fish. U. S. Environmental Protection Agency. EPA/444/4-89-001.

Webber, E. C. 2006. Stream quality in six streams of the Tallapoosa Watershed – Final Report. Submitted to the Research Committee of the Tallapoosa Watershed Project. 19 pp.

VIII. APPENDICES

• APPENDIX A - Press Releases

Ag Illustrated   Vol. 2, No. 4   Summer Issue 2005

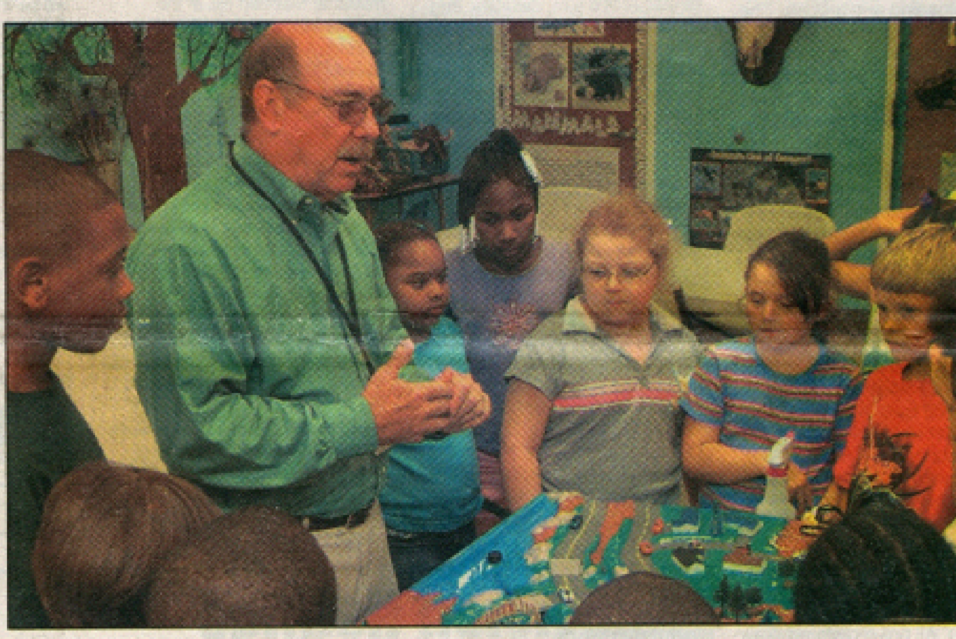
Tommy Futral, Extension coordinator in Tallapoosa County, shows participants in the Tallapoosa Watershed Project (TWP) meeting how to make a rain garden. TWP, which Involves CoAg fisheries faculty, held the workshop in May.

Ag Illustrated, the College of Agriculture, Auburn University, vol. 2 no. 4

Alexander City Outlook   *August 24, 2005*

Keeping it clean

Extension agent spends the day teaching Stephens students the importance of water quality



Story and photos by Amy Redd

Water pollution may not often come up for discussion among elementary school students but Tuesday some students learned that it is never too early start caring about the environment.

County Extension Agent Tommy Futral talked with third and fourth grade students in Ann Goree's QUEST enrichment program class at Stephens Elementary about the impact individuals have on the environment. The educational program was sponsored by the Clean Water Partnership and the Tallapoosa Watershed Project, he said.

"We try to convey to the kids the importance of water in most aspects of daily life and also teach them the differ-

*See **WATER**, Page 3A* ▶

Starting early: Tuesday, Extension Agent Tommy Futral spent the day at Stephens Elementary teaching students about water quality. He used a model of the lake and the many situations that could cause the water to become polluted. The program was taught to the QUEST classes.

The Outlook – Alexander City

Alexander City Outlook November 16, 2005

Students add new habitat to Sportplex

By Kelly Caldwell

Outlook News Editor

Kelly Caldwell / *The Outlook*

Adding to the environment: Tenisha Williams, left, and Eddie Rodda were two of the students selected to help create the pocket wetland at the Charles E. Bailey Sr. Sportplex.

When construction began on the Charles E. Bailey Sr. Sportplex began in 1984, little thought was put into what would happen when the stream running through the Sportplex was changed.

Now more than 20 years later, the Tallapoosa County Cooperative Extension System along with help from Auburn University and students at Radney School are creating a more natural habitat around the stream.

*See **HABITAT**, Page 3*

"We are not pointing fingers at why things were done the way they were," Tommy Futral, extension agent, said. "We are just trying to mimic the stream up above that hasn't been altered."

More than 15 students and teachers helped Roger Burkhead, Eve Brantley and Futral build a pocket wetland Monday at the Sportplex.

"The purpose of a wetland is to filter water," Futral said. "This is a pocket wetland in that it is real small."

The wetland was dug a week ago, but the students helped plant irises, trees and grasses around the area.

"This is ideal for the students because the school is five minutes away," Futral said. "They have to study water quality and they have even studied about pocket wetlands. They had never seen one until they came down here today."

The purpose of constructing the wetland is not only help filter the water, but also promote a more natural habitat that will be conducive to animal and plant life.

"We are planting the trees because it will give the stream more shade," Futral said. "It gets too hot right now because there is no shade."

When the water gets too hot, it kills the green algae, which makes the water brown. The shade will allow green algae to grow and will be more attractive for fish and other animals to live.

"There will be much more diverse micro-invertebrate and fish species that will live here because of the shade," Futral said.

Another benefit of the pocket wetland is that it will be a breeding ground for frogs and a natural enemy of mosquitoes, which grow in standing water.

"This may seem like a small project to some people but the learning tool it provides is invaluable," Futral said. "When we are finished, the students will have a better understanding of our natural resources and how they all relate together."

The Outlook – Alexander City

• **APPENDIX B - Abstracts and Conference Presentations**

Alabama Fisheries Association Annual Conference: January 25, 2005. Auburn, AL:

Tallapoosa Watershed Project: Integration of Research, Education and Extension for Addressing Nutrient Dynamics in Southeastern Watersheds

William Deutsch and David Bayne
Department of Fisheries and Allied Aquacultures
Auburn University
Auburn, AL 36849-5419

Luoheng Han
Department of Geography
University of Alabama
Tuscaloosa, AL 35487-0322

John Glasier
Lake Watch of Lake Martin
PO Box 72, Alexander City, AL 35011

Robin Nelson
Alabama Department of Education
Montgomery, AL 36104

The Tallapoosa Watershed Project (TWP) is a three-year, USDA/CSREES-funded project which is designed to provide a transferable model of stakeholder partnerships for addressing watershed-scale nutrient dynamics. The TWP integrates a variety of research, education, and extension activities to provide relevant, locally-generated watershed information. The first year of research concentrated on Lake Martin and upstream tributaries, and measured nutrients, chlorophyll *a*, suspended solids and other chemical parameters using both Standard Methods and low-tech protocols of Alabama Water Watch. Concurrently, two methods of close-range hyperspectral sensing and Landsat satellite imagery were used to analyze water quality. Nutrient and sediment loading in the watershed is being estimated by GIS modeling. Research data are being adapted for education and extension in the form of in-classroom curricula, teacher workshops, an annual, “State of Our Watershed” conference, a public display at the environmental center of Camp ASCCA and a TWP website. Year 2 activities will expand to Lake Wedowee and continue at Lake Martin. The project has benefited from collaboration with the Tallapoosa Clean Water Partnership and numerous, related projects for enhancing science education and developing watershed management plans.

USDA CSREES Southern Region Water Quality Conference: October 25, Lexington, KY:

An Integrated Approach of Research, Outreach and Management in the Tallapoosa River Basin, Alabama
Presenter: William Deutsch

The USDA/CSREES-funded Tallapoosa Watershed Project integrates research, education and extension activities to address nutrient loading and eutrophication in the Tallapoosa River Basin (east-central Alabama). Research has focused on concurrent measurements of water quality using Standard Methods laboratory analyses, EPA-approved volunteer water quality monitoring protocols, hand-held spectrometers and satellite imagery. A cost-efficiency study of methods is designed to identify the optimal mix of technologies for basin-scale assessment of nutrients. Outreach activities include the development of aquatic science school curricula, exhibits at an environmental education center, teacher workshops and a State of Our Watershed annual conference. Numerous collaborators within local government, the state environmental regulatory agency, schools and the Alabama Clean Water Partnership have significantly extended the scope and financial support of the project. A major goal of the TWP is to provide a transferable, cost-effective model of river basin management that uses a science-based, community-based approach.

Monitoring Water Quality and Nutrient Dynamics for the Middle Tallapoosa Watershed Using Remote Sensing and GIS Techniques
Presenter: Luoheng Han, University of Alabama

As a part of the Tallapoosa Watershed Project funded by USDA/CSREES, nutrient dynamics of the Lake Martin watershed (east-central Alabama) were studied using remote sensing techniques and Geographic Information Systems (GIS) modeling. The hyperspectral reflectance data were collected at close range using two types of handheld spectrometers, coincident with over-flights of the Landsat 5 satellite and in situ water sampling on two occasions in 2004. Lake maps of chlorophyll a concentration and trophic state were created using the Landsat TM data. The Soil and Water Assessment Tool (SWAT) was used to model nutrient loading for the watershed. Our study indicates that remote sensing and GIS can be very effective components of an optimal mix of technologies for river basin research and management.

USDA CSREES National Water Conference, February 5-9, 2006, San Antonio, Texas:

Innovations in Understanding Basin-Scale Nutrient Dynamics

William Deutsch, David Bayne, Eric Reutebuch, Omar Romagnoli and Wendy Seesock
Department of Fisheries and Allied Aquacultures
Auburn University
Auburn, AL 36849-5419

Luoheng Han
Department of Geography
University of Alabama
Tuscaloosa, AL 35487-0322

John Glasier and Richard Bronson
Lake Watch of Lake Martin
PO Box 72, Alexander City, AL 35011

Thomas Futral
Alabama Cooperative Extension System
125 N. Broadnax Street, Room 23
Dadeville, AL 36853

Sallye Longshore
Alabama State Department of Education
50 N. Ripley Street
Montgomery, AL 36130-2101

The 3-year, USDA/CSREES-funded Tallapoosa Watershed Project (TWP) began in Alabama in 2003 to better understand nutrient loading in a river basin. The TWP was implemented by partners from universities, citizen groups, schools, the extension system and the environmental regulatory agency, so that research findings would be appropriately extended to classrooms, the general public and policy makers. Scores of sites on two reservoirs and six tributaries were sampled for two years using standard methods of field and laboratory analyses. Citizen volunteers and researchers concurrently used EPA-approved "water watch" techniques, two types of hand-held spectroradiometers and satellite imagery to directly or indirectly analyze water for nutrients. The comparative advantages of each monitoring approach were evaluated to determine an optimal mix of technologies for measuring, modeling and managing nutrients. An aquatic science curriculum called *Living Streams* was developed and piloted in several schools to teach biomonitoring and the impact of nutrients on aquatic life. A TWP website, sponsored exhibits at an environmental education center and an annual "State of Our Watershed" conference have long-term impact potential for informing the public about water quality, biota and nutrients. The stakeholder-driven, TWP model is transferable and can advance current approaches for addressing nutrients in cost-effective ways.

Association of American Geographers Annual Meeting, March 7-11, 2006,Chicago, Illinois:

Estimating water quality in a man-made lake in Alabama using multi-temporal spectral reflectance

Luoheng Han
Department of Geography
University of Alabama
Tuscaloosa, AL 35487-0322

John Glasier
Lake Watch of Lake Martin
PO Box 72, Alexander City, AL 35011

William Deutsch, David Bayne, Eric Reutebuch, and Wendy Seesock
Department of Fisheries and Allied Aquacultures
Auburn University
Auburn, AL 36849-5419

This study is a part of "A Transferable Model of Stakeholder Partnerships for Addressing Nutrient Dynamics in Southeastern Watersheds," which is a project that is funded through the CSREES of USDA. The purpose of the study was to 1) to characterize the relationship between spectral reflectance and major water quality parameters, such as chlorophyll a, total suspended solids (TSS), and Secchi disk visibility; and 2) to develop algorithms that can be used to predict these major water quality indicators using spectral reflectance. The water sampling and spectral data collection were simultaneously conducted over Lake Martin of Alabama. There are a total of 25 sampling sites over about 160-km2 water area covered by the lake. Six monthly data collections from April to October except May were operated in 2004. The upwelling radiance was collected over the water surface at each sampling site and downwelling irradiance was collected over a Spectralon reference panel. The portable spectroradiometer used has the spectral range from 350 to 1050 nm with 1 nm spectral resolution. In addition to utilizing the reflectance itself, the first derivatives of the reflectance were computed. Both reflectance and first derivatives were correlated with the water quality parameters. After analyzing each monthly reflectance-water quality relationship, all six datasets were combined and a multi-temporal algorithm was developed for each water quality parameter.

NALMS Southeastern Lake and Watershed Management Conference, March 8-10, 2006, Columbus, Georgia:

ALTERNATIVE CAPABILITIES FOR VOLUNTEER MONITORING THE TROPHIC STATUS OF LAKE MARTIN, ALABAMA

John Glasier and Richard Bronson, Lake Watch of Lake Martin, PO Box 72, Alexander City, AL 35011, 256-234-1454, jglasier@charter.net, dbronson@charter.net; Luoheng Han, Department of Geography, University of Alabama, Tuscaloosa, AL 35487-0322, 205-348-4981, lhan@bama.ua.edu; William Deutsch, David Bayne, Eric Reutebuch, and Wendy Seesock, Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, AL 36849-5419, 334-844-4786, deutswg@auburn.edu, baynedr@auburn.edu, reuteem@auburn.edu, seesowc@auburn.edu; Chris Abbett, Alexander City Sugar Creek Waste Water Treatment Laboratory, PO Box 552, Alexander City, AL 35011-0552, 256-409-2036, sugarcreekwwtp@bellsouth.net.

This study examined a mix of technologies and demonstrated partnership synergies that assisted citizen-volunteer monitoring of lake nutrient enrichment and trophic status effects in Lake Martin, Alabama. The three-year USDA/CSREES funded project entitled, "A Transferable Model of Stakeholder Partnerships for Addressing Nutrient Dynamics in Southeastern Watersheds," incorporated the support and expertise of researchers from Auburn University's Department of Fisheries and Allied Aquacultures, University of Alabama's Department of Geography, Alabama's Department of Environmental Management, the Alexander City, Alabama Sugar Creek Wastewater Laboratory, and the intrepid spirit of citizen volunteers from Lake Watch of Lake Martin. Lake Martin is a 40,000-acre reservoir with nearly 750 miles of shoreline, the largest reservoir in the Tallapoosa River Basin in east-central Alabama. EPA-approved Alabama Water Watch sampling techniques were used coincident with standard methods of field and laboratory analyses for monthly sampling at selected in-lake stations during the 2004-05 growing seasons, April through October. Alternative capabilities were demonstrated that exploit the spectral information derived from the optically active properties of sampled waters to estimate concentrations of chlorophyll *a*, total suspended solids (TSS), and Secchi disk visibility (SDV). The sampling regime was synchronized with monthly recurring Landsat TM coverage opportunities. Two types of field-portable spectroradiometers and a digital camera were used to measure *in situ* the spectral reflectance and water chromaticity related to chlorophyll *a*, TSS, and SDV. Both reflectance and spectral curve first derivatives were correlated with these water quality variables. After analyzing each monthly reflectance-water quality relationship, all monthly data sets were combined and a multi-temporal algorithm was developed for each water quality variable. Spatial and temporal trends of chlorophyll concentrations and trophic status according to the Carlson Trophic State Index were also modeled correlating Landsat TM data and water sample data. Preliminary evaluation of the comparative advantages of each monitoring approach recommends employing an optimal mix of capabilities that are suitable and affordable for citizen-volunteer use in their endeavors to assess lake nutrient conditions, to inform others of findings, and to influence nutrient management policies and planning.

NALMS Southeastern Lake and Watershed Management Conference, March 8-10, 2006, Columbus, Georgia:

A TRANSFERABLE MODEL OF STAKEHOLDER PARTNERSHIPS FOR ADDRESSING BASIN-SCALE NUTRIENT DYNAMICS

William Deutsch, David Bayne, Eric Reutebuch, Omar Romagnoli and Wendy Seesock, Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, AL 36849-5419, 334-844-4786, deutswg@auburn.edu, baynedr@auburn.edu, reuteem@auburn.edu, romagod@auburn.edu, seesowc@auburn.edu; Luoheng Han, Department of Geography, University of Alabama, Tuscaloosa, AL 35487-0322, 205-348-4981, lhan@bama.ua.edu; Richard Bronson and John Glasier, Lake Watch of Lake Martin, PO Box 72, Alexander City, AL 35011, 256-234-1454, dbronson@charter.net, jglasier@charter.net; Thomas Futral, Alabama Cooperative Extension System, Dadeville, AL 36853, 256-825-1050, tfutral@aces.edu; Sallye Longshore, Alabama State Department of Education, Montgomery, AL 36130-2101, 334-353-9151, slongshore@alsde.edu; Chris Abbett, Alexander City Sugar Creek Waste Water Treatment Laboratory, PO Box 552, Alexander City, AL 35011-0552, 256-409-2036, sugarcreekwwtp@bellsouth.net.

The 3-year, USDA/CSREES-funded Tallapoosa Watershed Project (TWP) began in Alabama in 2003 to better understand nutrient loading in a river basin. Stakeholder partners from universities, citizen groups, schools, the extension system and the environmental regulatory agency, implemented the TWP so that research findings would be appropriately extended to classrooms, the general public and policy makers. Scores of sites on two reservoirs and six tributaries were sampled for two years using standard methods of field and laboratory analyses. Citizen volunteers and researchers concurrently used EPA-approved "water watch" techniques, two types of hand-held spectroradiometers and satellite imagery to directly or indirectly analyze water for nutrients. The comparative advantages of each monitoring approach were evaluated to determine an optimal mix of technologies for measuring, modeling and managing nutrients. An aquatic science curriculum called *Living Streams* was developed and piloted in several schools to teach biomonitoring and the impact of nutrients on aquatic life. A TWP website, sponsored exhibits at an environmental education center and an annual "State of Our Watershed" conference have long-term impact potential for informing the public about water quality, biota and nutrients. The stakeholder-driven, TWP model is transferable and can advance current approaches for addressing nutrients in cost-effective ways.

• **APPENDIX C - Figures of Preliminary Results**

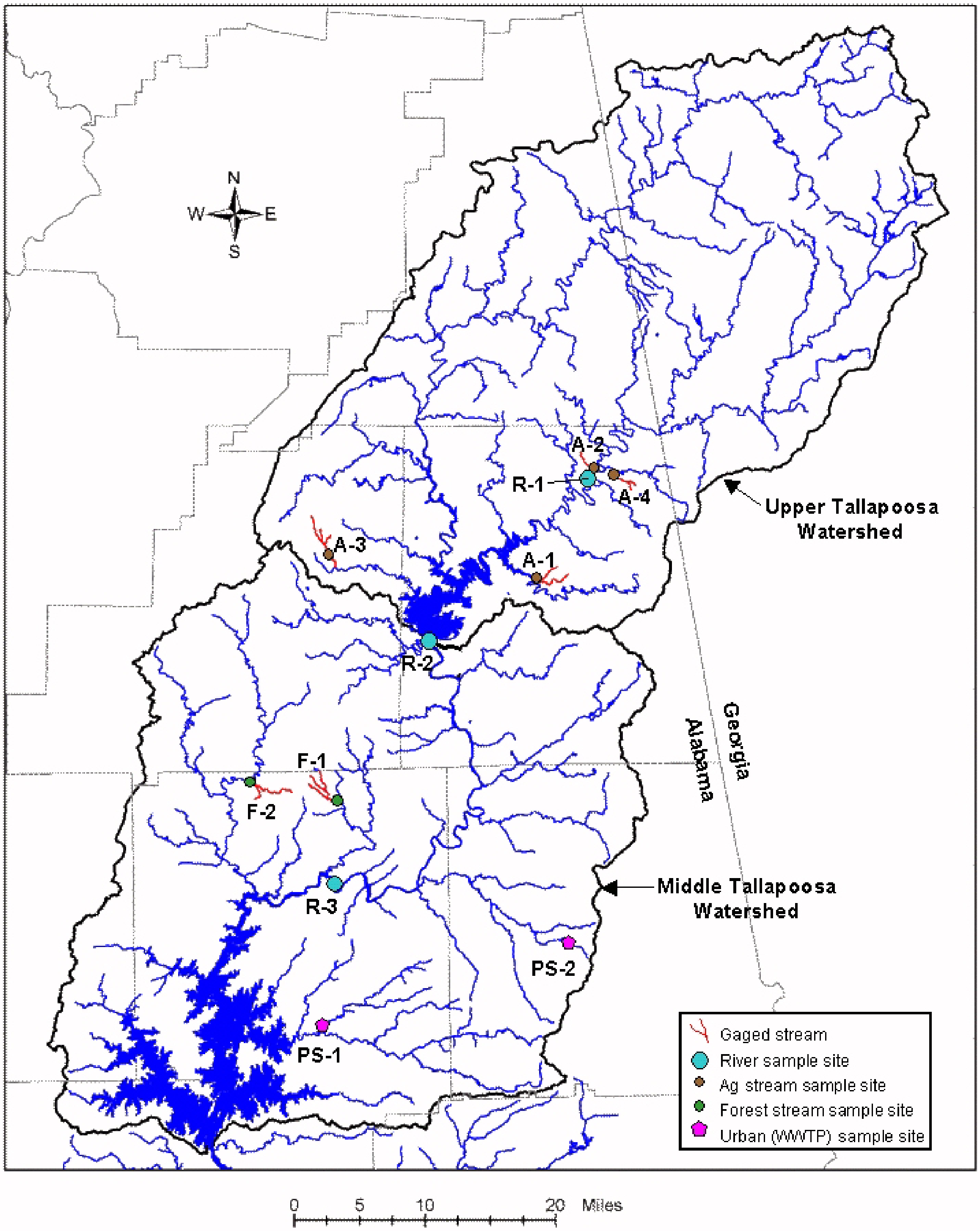


Figure 1. Watershed sampling sites (stream, river and point source sites).

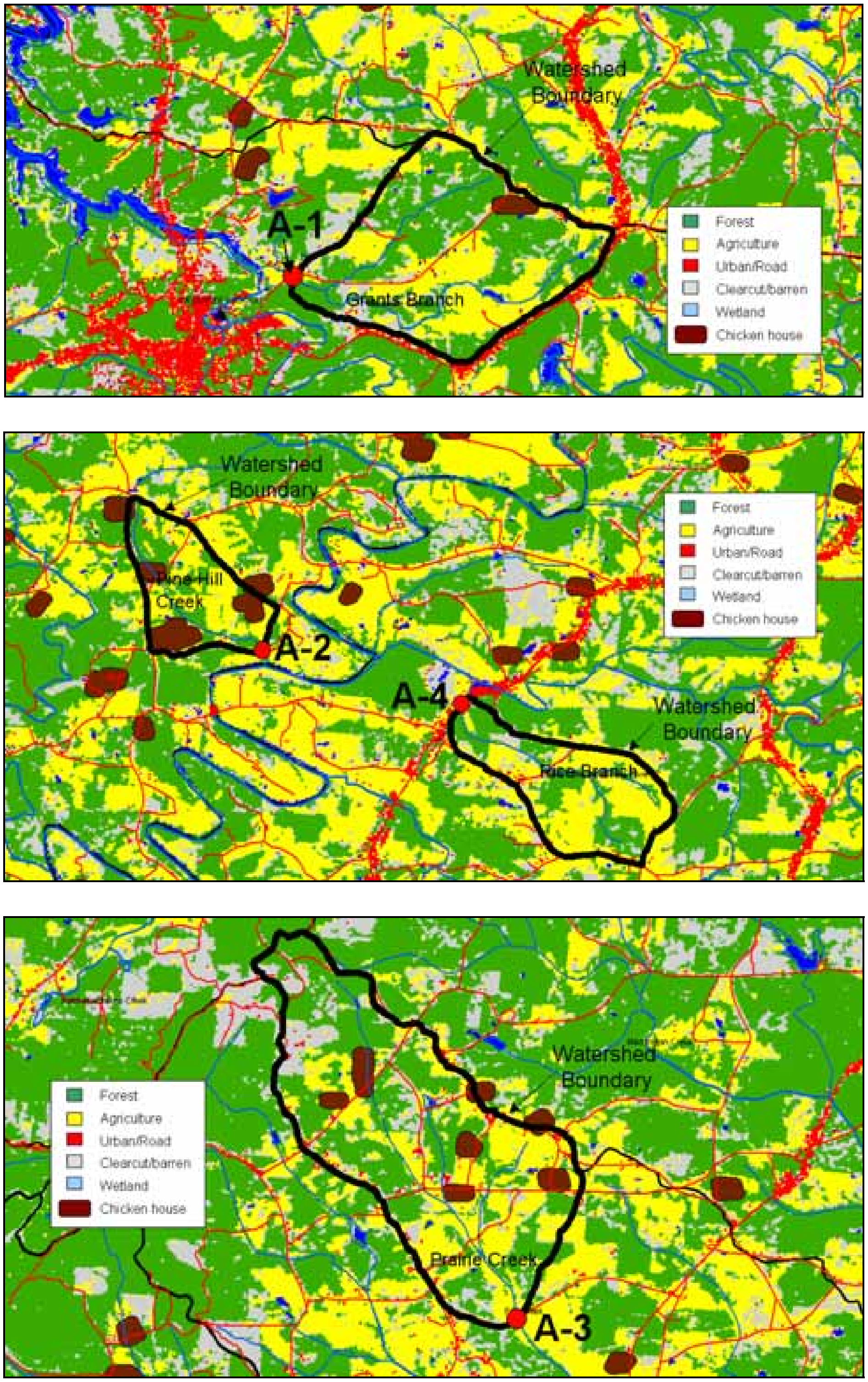


Figure 2. Land use/land cover (circa 2001, not to scale, modified from land cover data from the Alabama Gap Analysis Project, see www.auburn.edu/gap) of small streams draining agricultural lands. A-1 = Grants Branch, A-2 = Pine Hill Creek, A-3 = Prairie Creek and A-4 = Rice Branch.

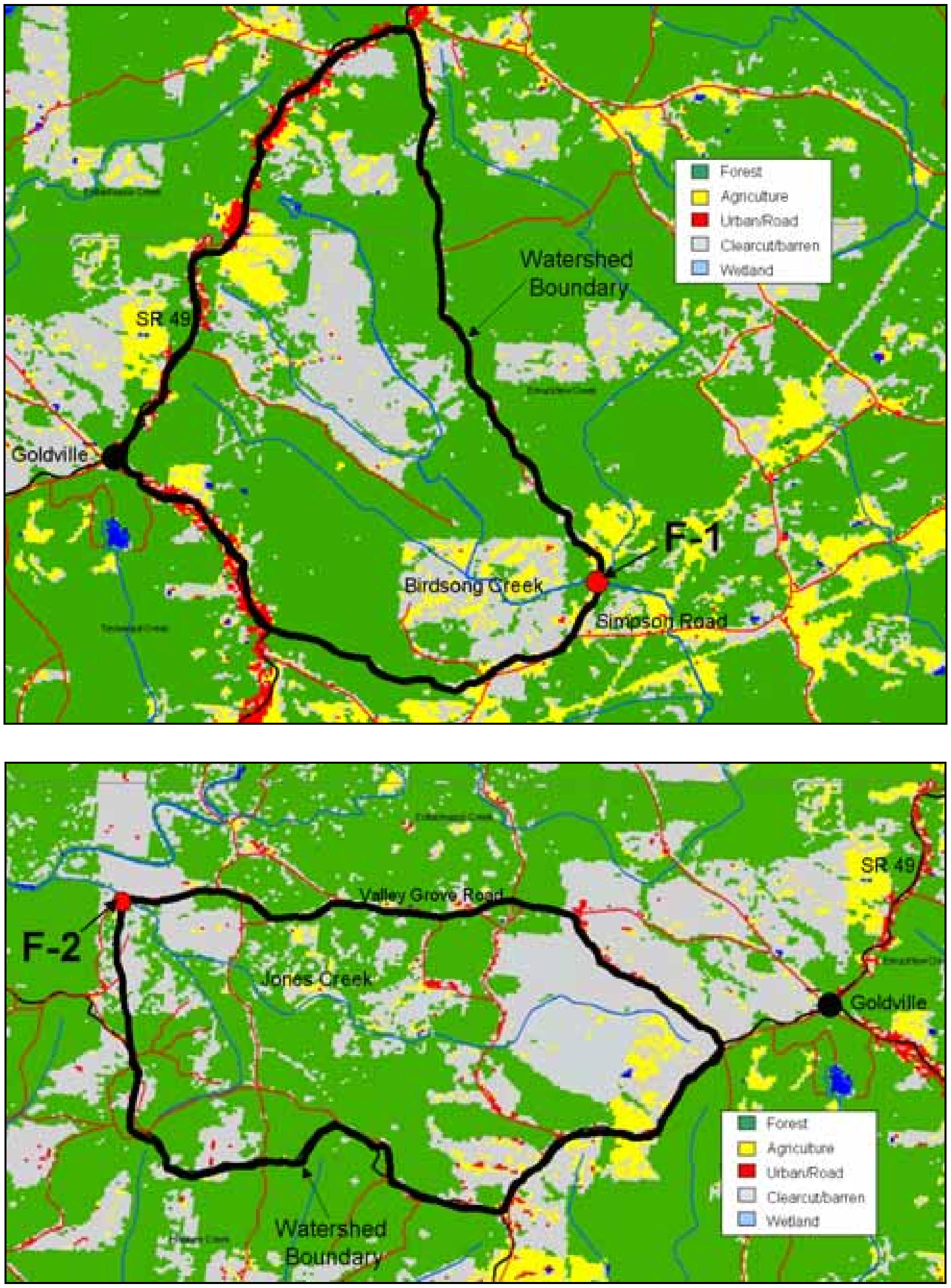


Figure 3. Land use/land cover (circa 2001, not to scale, modified from land cover data from the Alabama Gap Analysis Project, see www.auburn.edu/gap) of small streams draining forested lands. F-1 = Birdsong Creek and F-2 = Jones Creek.

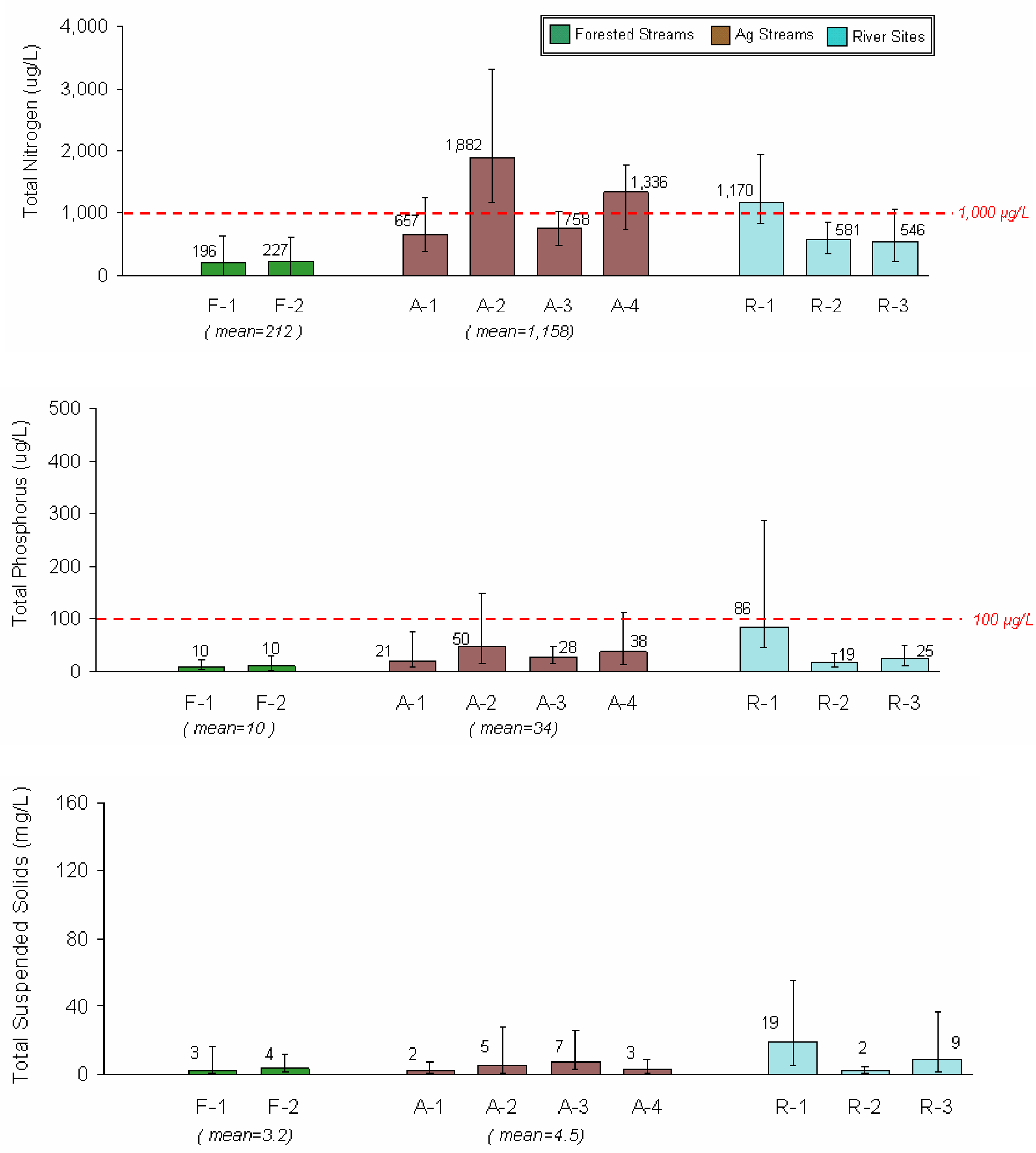


Figure 4. Average total nitrogen, total phosphorus and total suspended solids concentrations of stream and river sites sampled monthly by AU from February 2004 – October 2005 (21 sample dates). Brackets on bars represent the range (minimum and maximum), values above bars are averages.

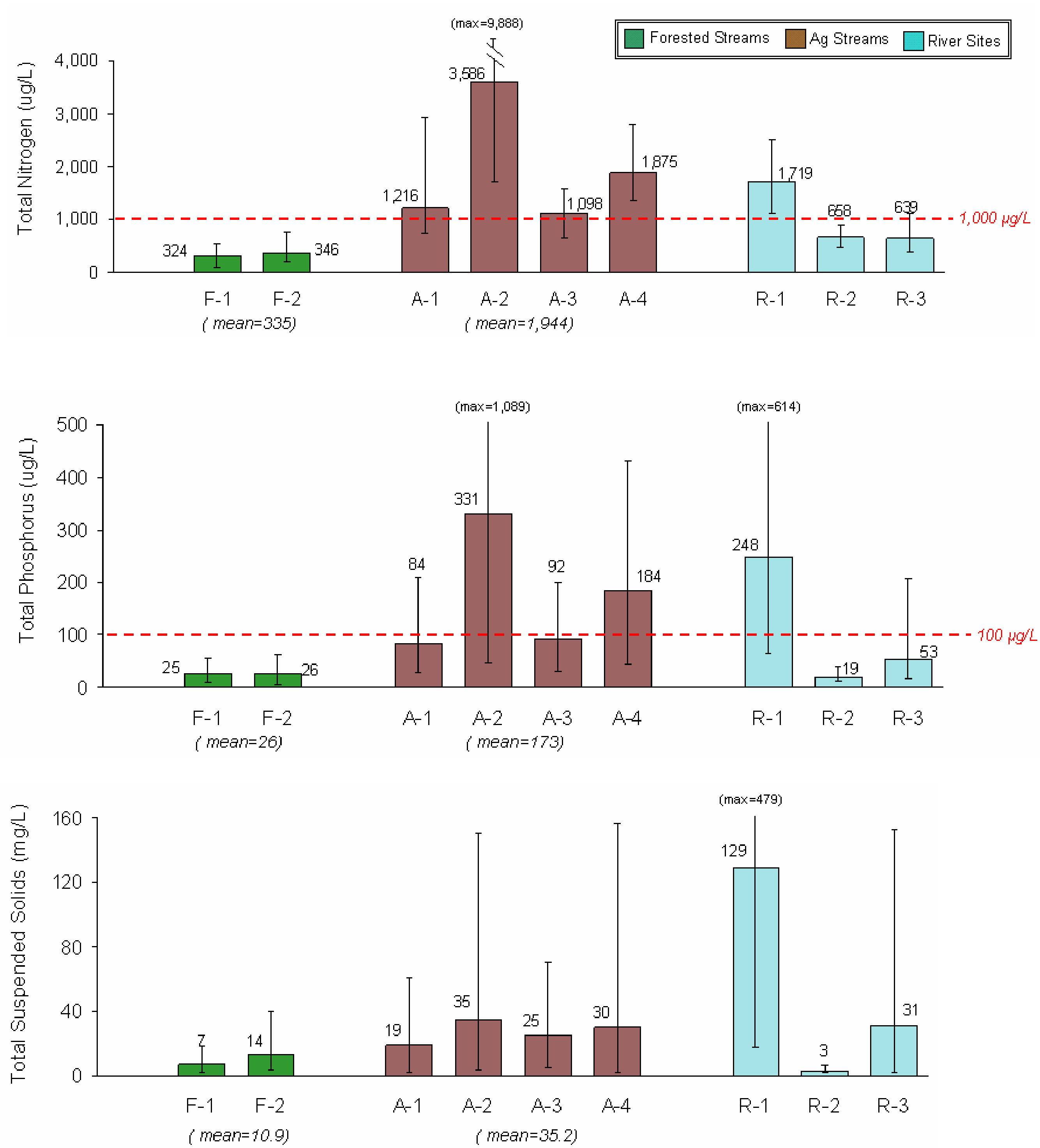


Figure 5. Average total nitrogen, total phosphorus and total suspended solids concentrations of stream and river sites sampled during rain events by AU from February 2004 – October 2005 (10 dates). Brackets on bars represent the range (minimum and maximum), values above bars are averages.

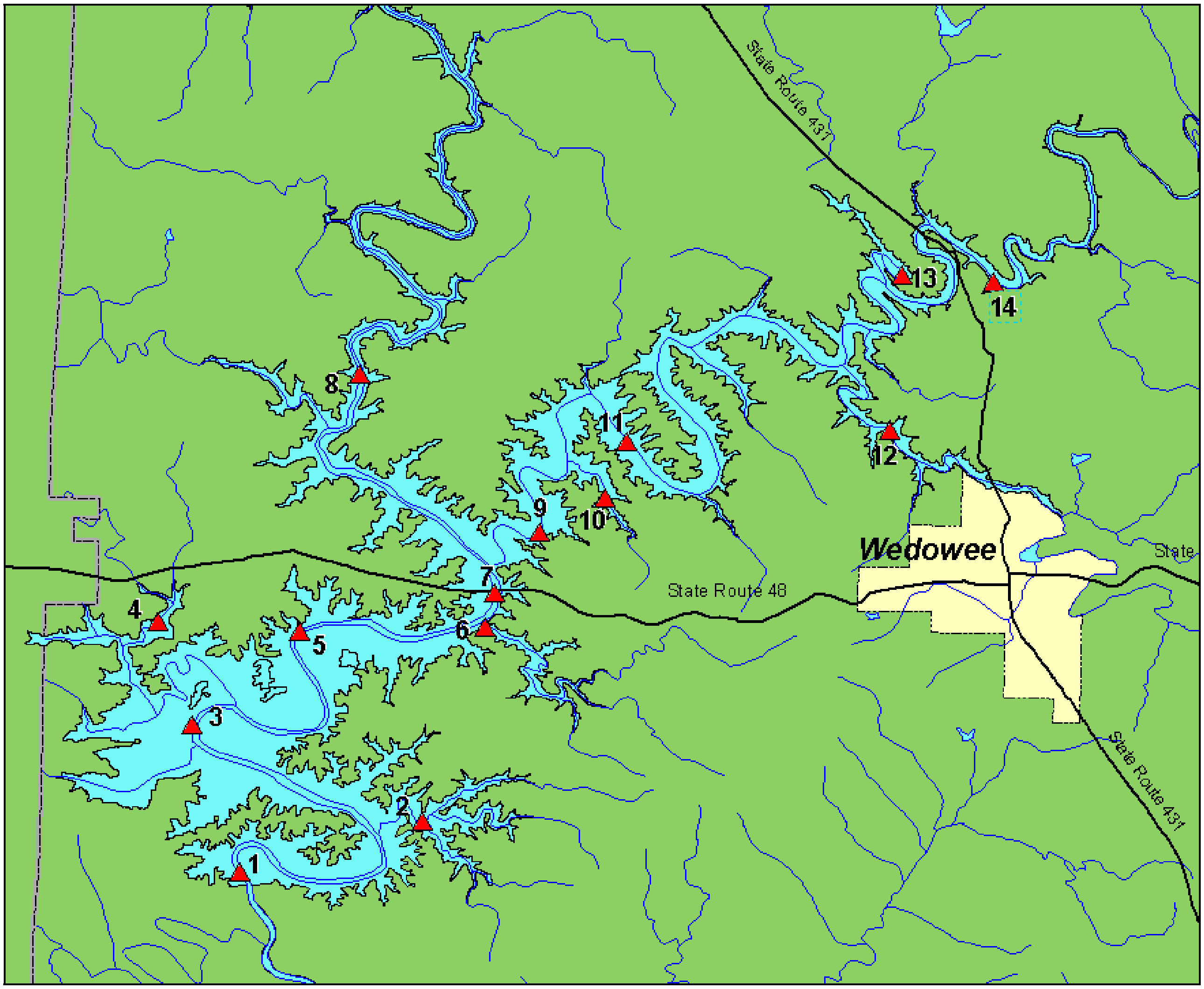


Figure 6. Auburn University Standard Methods sample sites on Lake Wedowee.

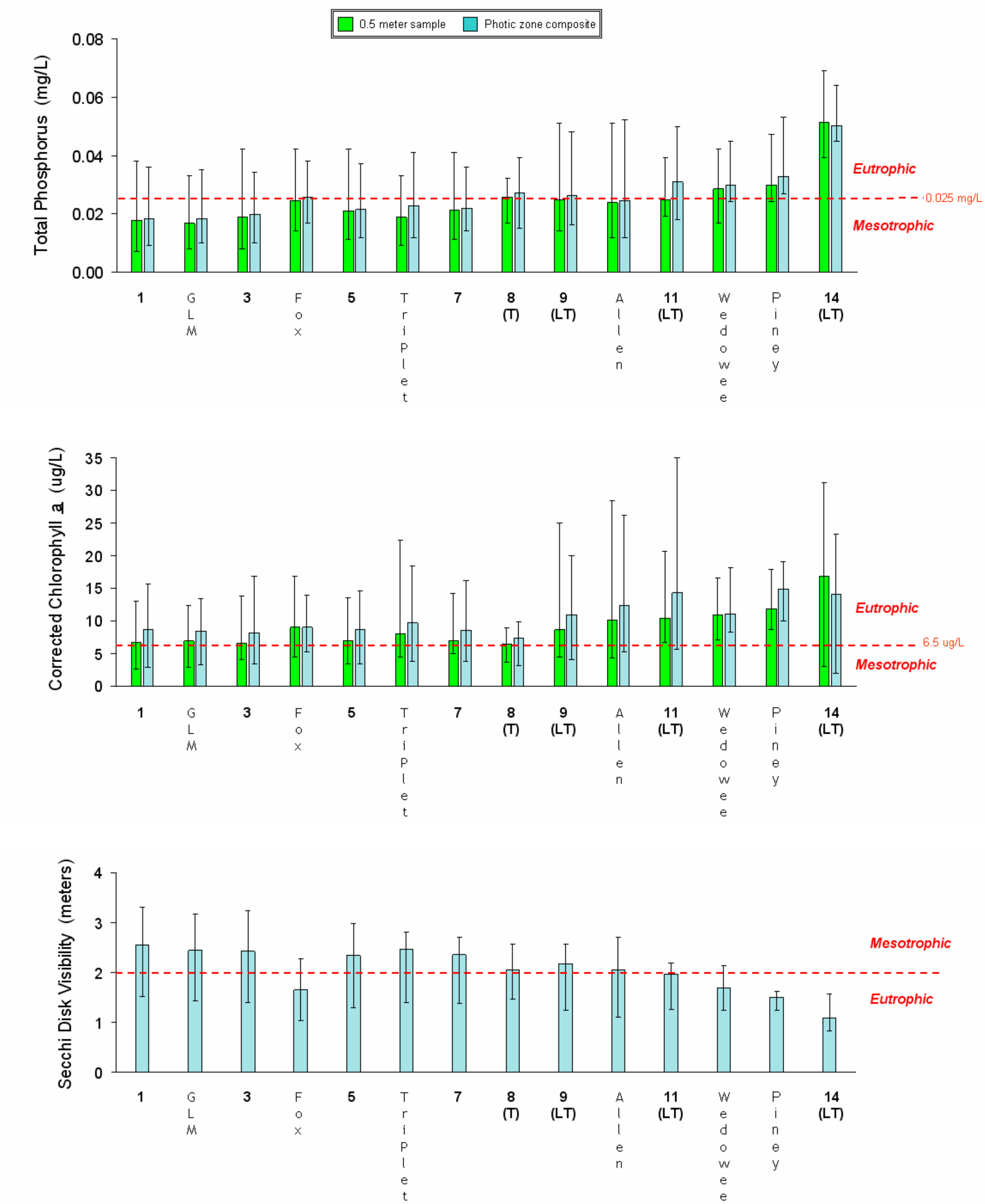


Figure 7. Growing season (April – October) average total phosphorus concentrations, Secchi disk visibility and chlorophyll a concentrations of sites on Lake Wedowee sampled by AU during 2005. Brackets on bars represent the range (minimum and maximum).

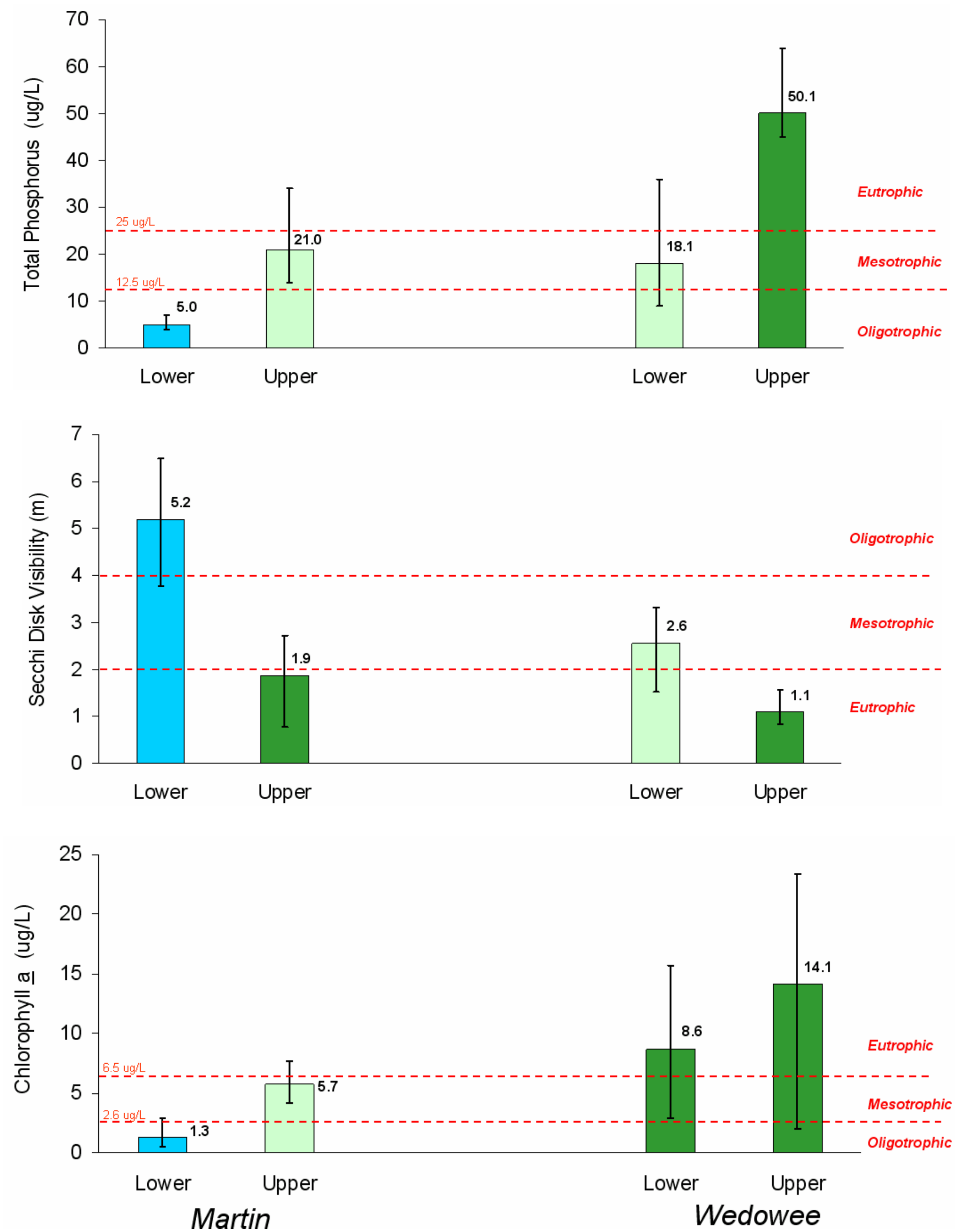


Figure 8. Growing season (April – October) average total phosphorus concentration, Secchi disk visibility and chlorophyll a concentration of areas sampled by AU on lakes Martin (2004) and Wedowee (2005). Martin lower = site 4, upper = site 19, Wedowee lower = site 1, upper = site 14. Brackets on bars represent the range (minimum and maximum), values above bars are averages.

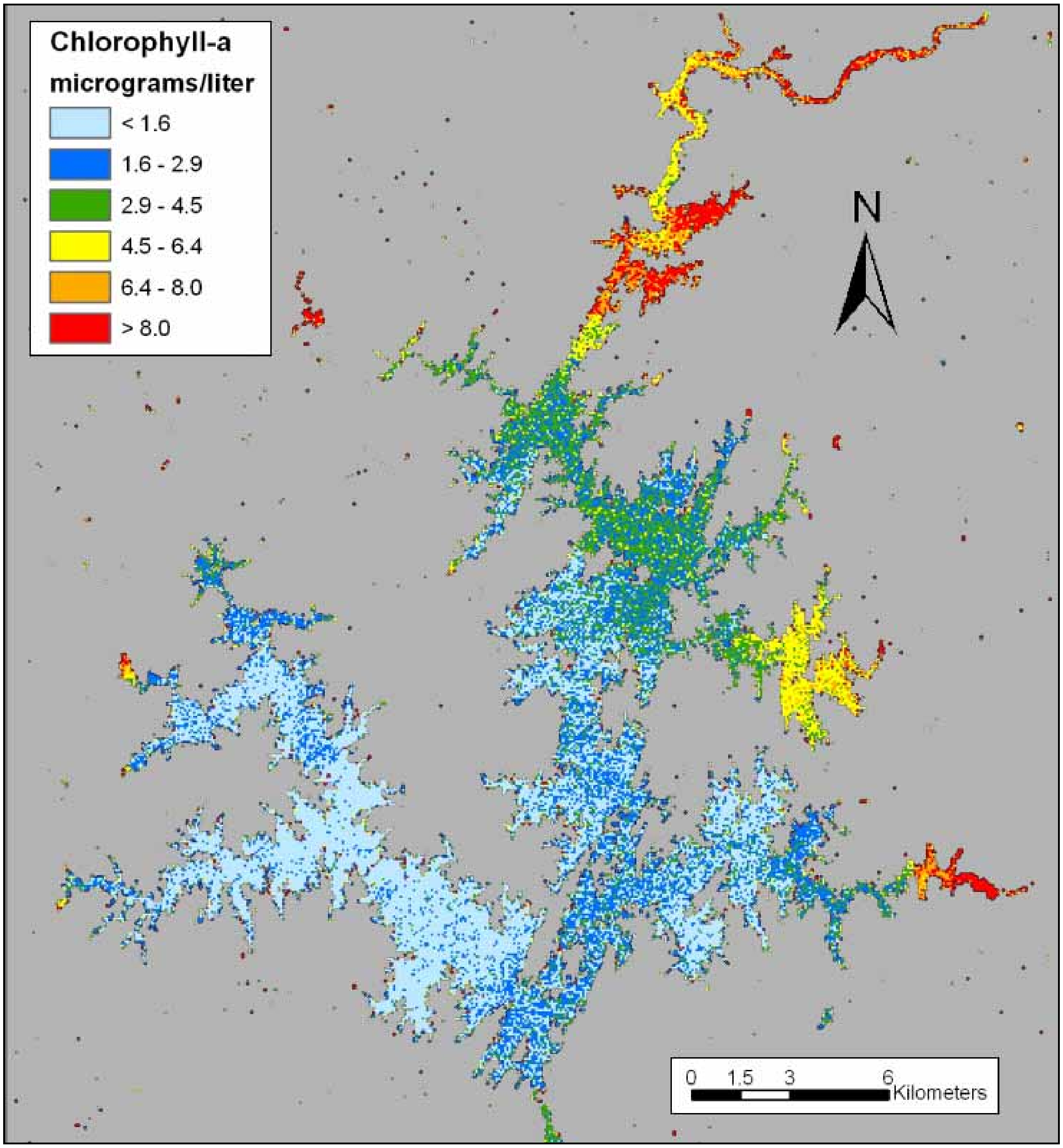


Figure 9. Chlorophyll a map of Lake Martin for September 22, 2004 generated from a Landsat TM image and coincident in-situ chlorophyll a measurements.

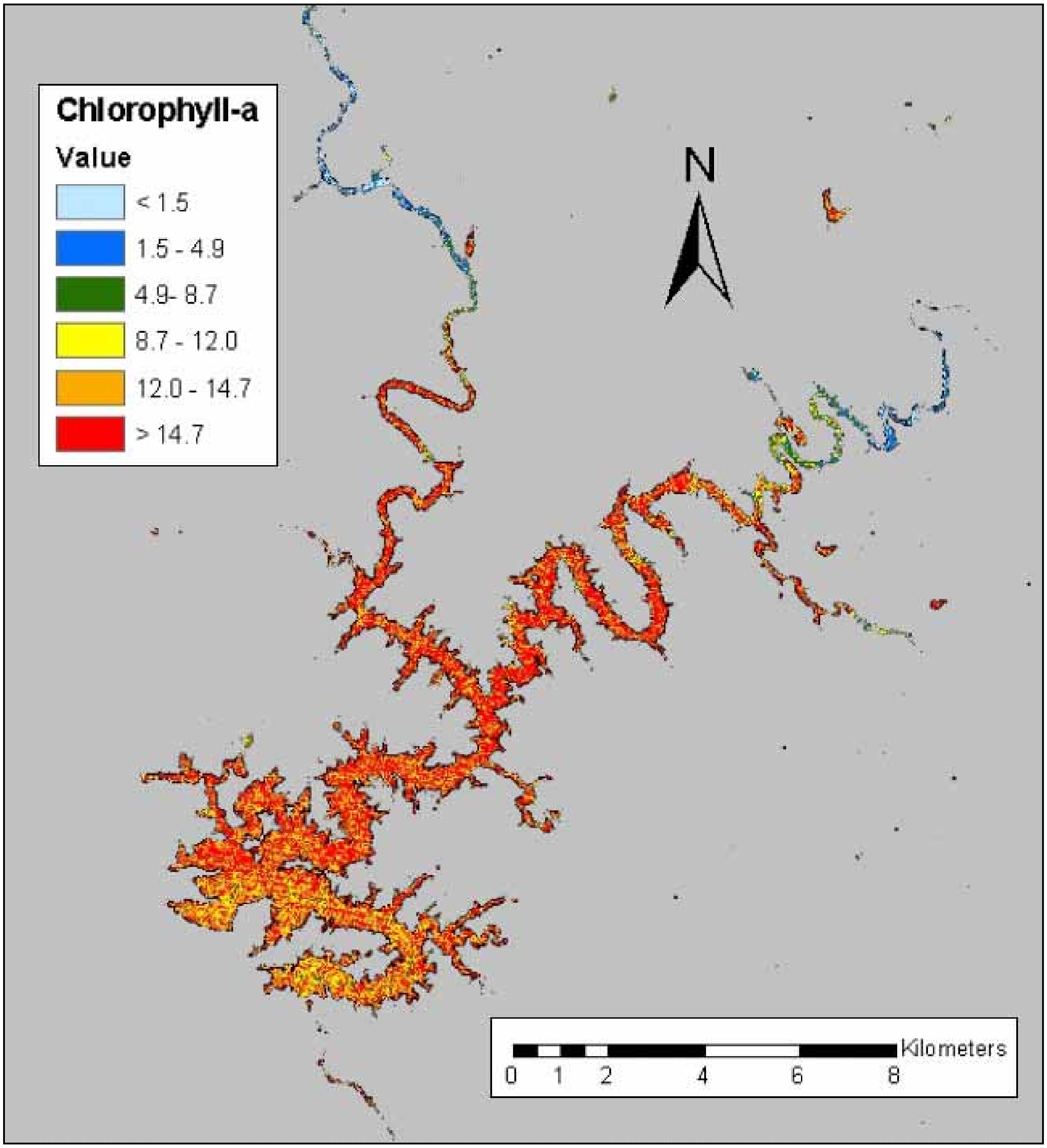


Figure 10. Chlorophyll a map of Lake Wedowee for April 18, 2005 generated from a Landsat TM image and coincident in-situ chlorophyll a measurements.

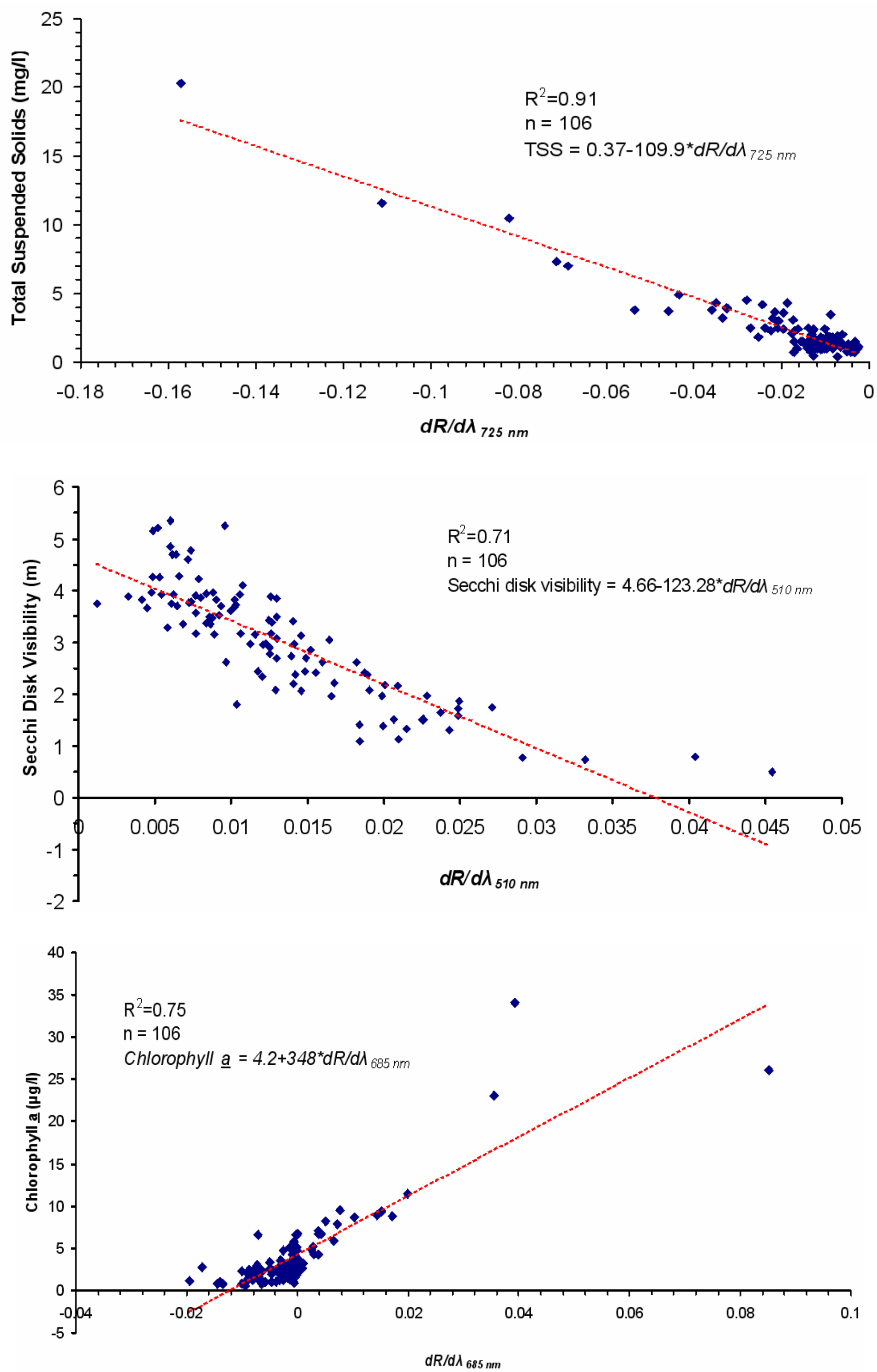


Figure 11. Regressions predicting TSS, Secchi disk visibility and chlorophyll a concentration from hyperspectral reflectance (first derivative) of Lake Martin water (2004 data, n = 106 readings).

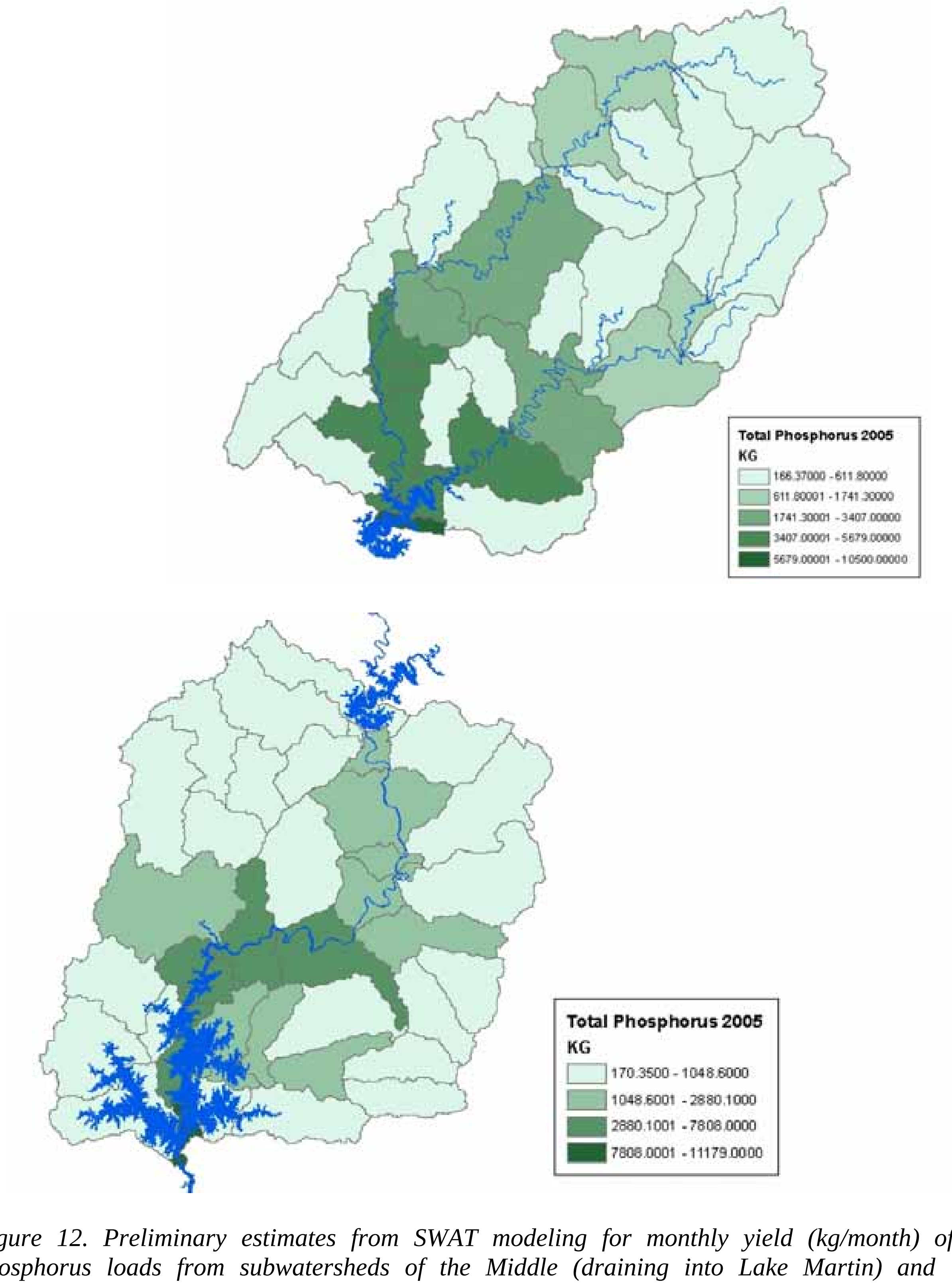
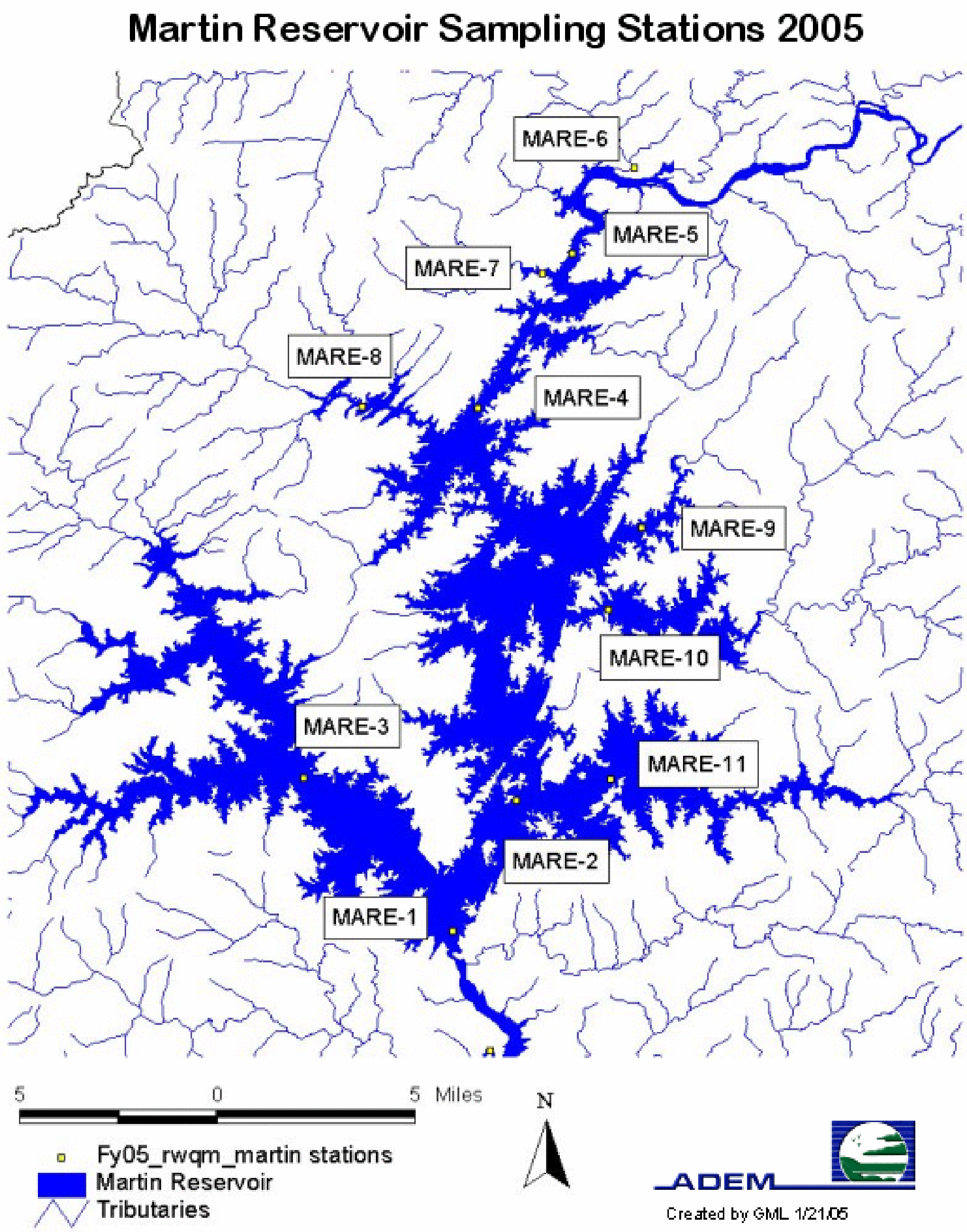


Figure 12. Preliminary estimates from SWAT modeling for monthly yield (kg/month) of total phosphorus loads from subwatersheds of the Middle (draining into Lake Martin) and Upper (draining into Lake Wedowee) Tallapoosa basins for April 2005.



Sation ID	Description	Sation ID	Description
MARE-1	@ Dam Forebay	MARE-6	@ Hillabee Cr
MARE-2	Upstream of Blue Creek	MARE-7	@ Coley Cr
MARE-3	Upstream of HWY 63 Bridge	MARE-8	@ Elkahatchee Cr
MARE-4	Upstream of Wind Creek	MARE-9	@ Manoy Cr
MARE-5	Upstream of Coley Creek	MARE-10	@ Sandy Cr
		MARE-11	@ Blue Cr

Figure 13. ADEM Standard Methods sample sites on Lake Martin.

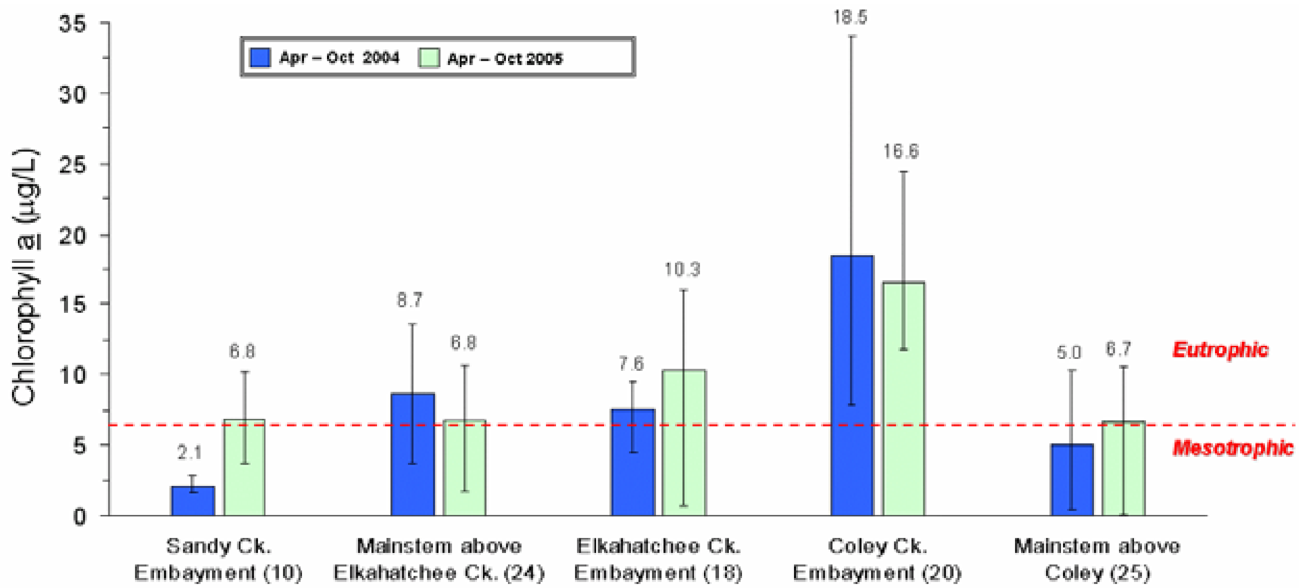
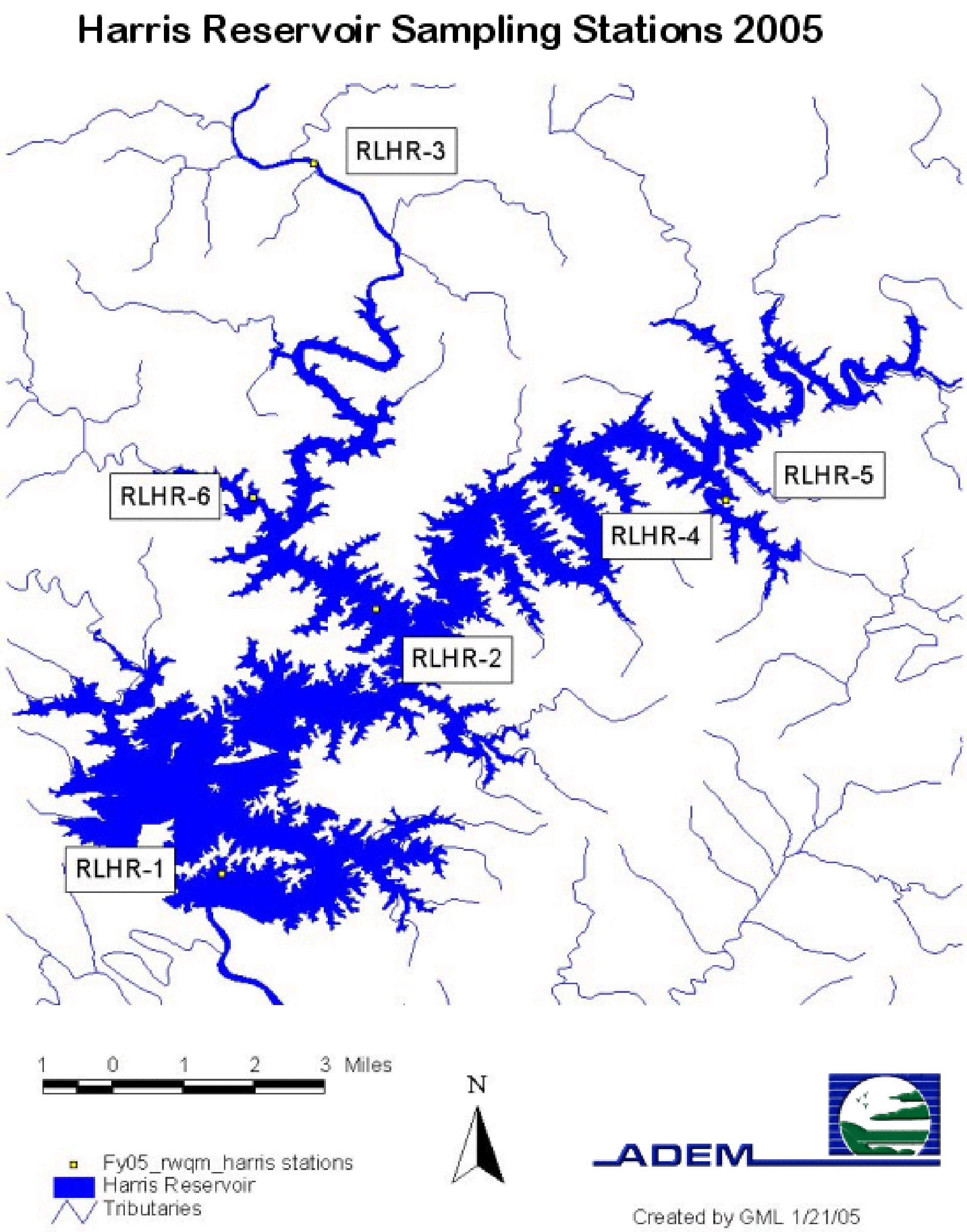


Figure 14. Growing season (April – October) average chlorophyll a (corrected) concentrations of sites on Lake Martin sampled at a depth of 0.5 meters by AU (2004 data) and ADEM (2005 data). The number in parentheses after the site's name is the AU site code. Brackets on bars represent the range (minimum and maximum), values above bars are averages.



Sation ID	Description
RLHR-1	@ Dam Forebay
RLHR-2	Upstream of Little Tallapoosa Confluence
RLHR-3	Downstream of Hwy 82
RLHR-4	Downstream of Hwy 29
RLHR-5	@ Wedowee Cr
RLHR-6	@ Mad Indian Cr

Figure 15. ADEM Standard Methods sample sites on Lake Wedowee (also called Lake Harris).

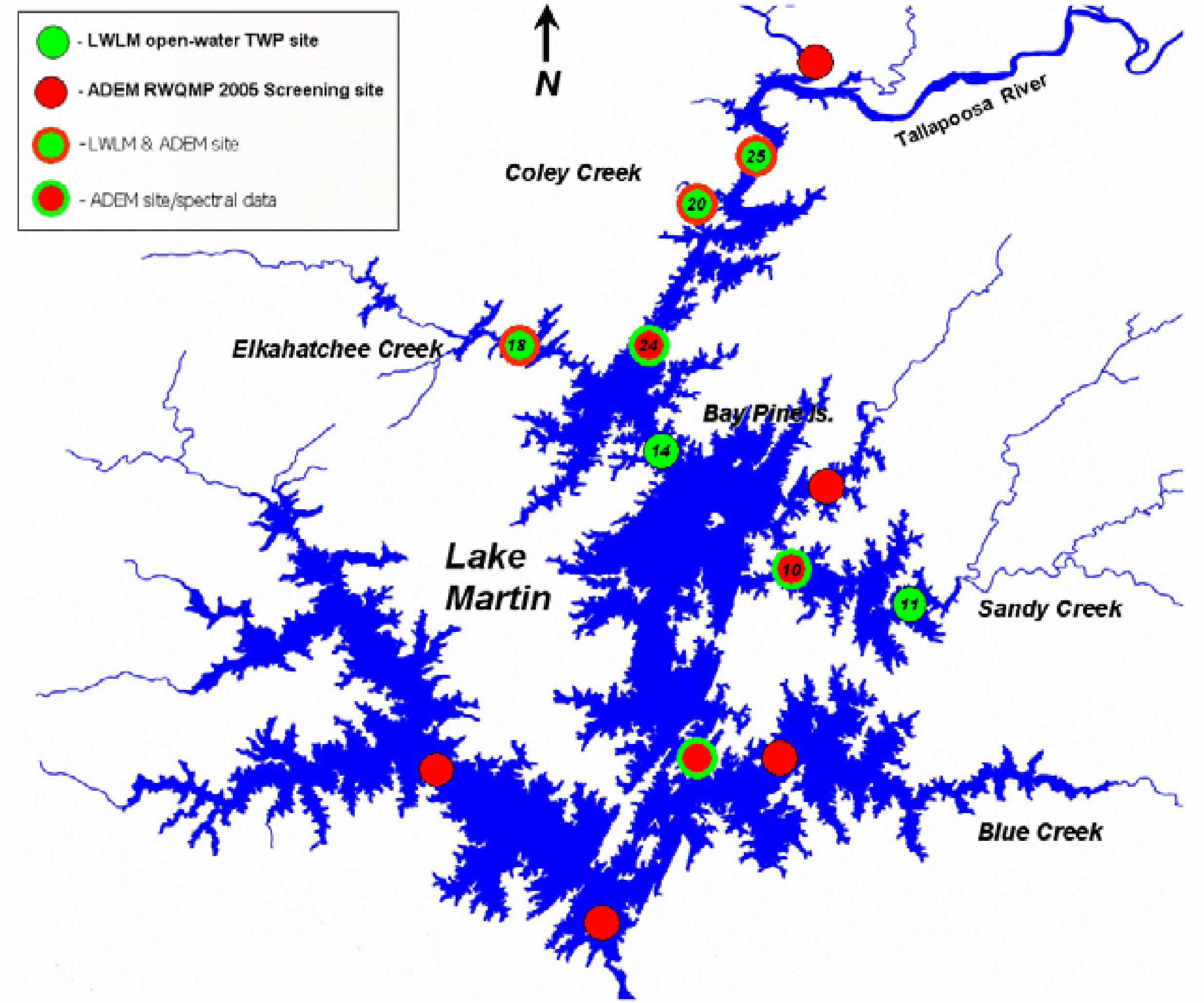


Figure 16. Lake Watch of Lake Martin and ADEM sample sites on Lake Martin. Site numbers (10, 11, 14, 18, 20, 24, 25) correspond to AU site codes.

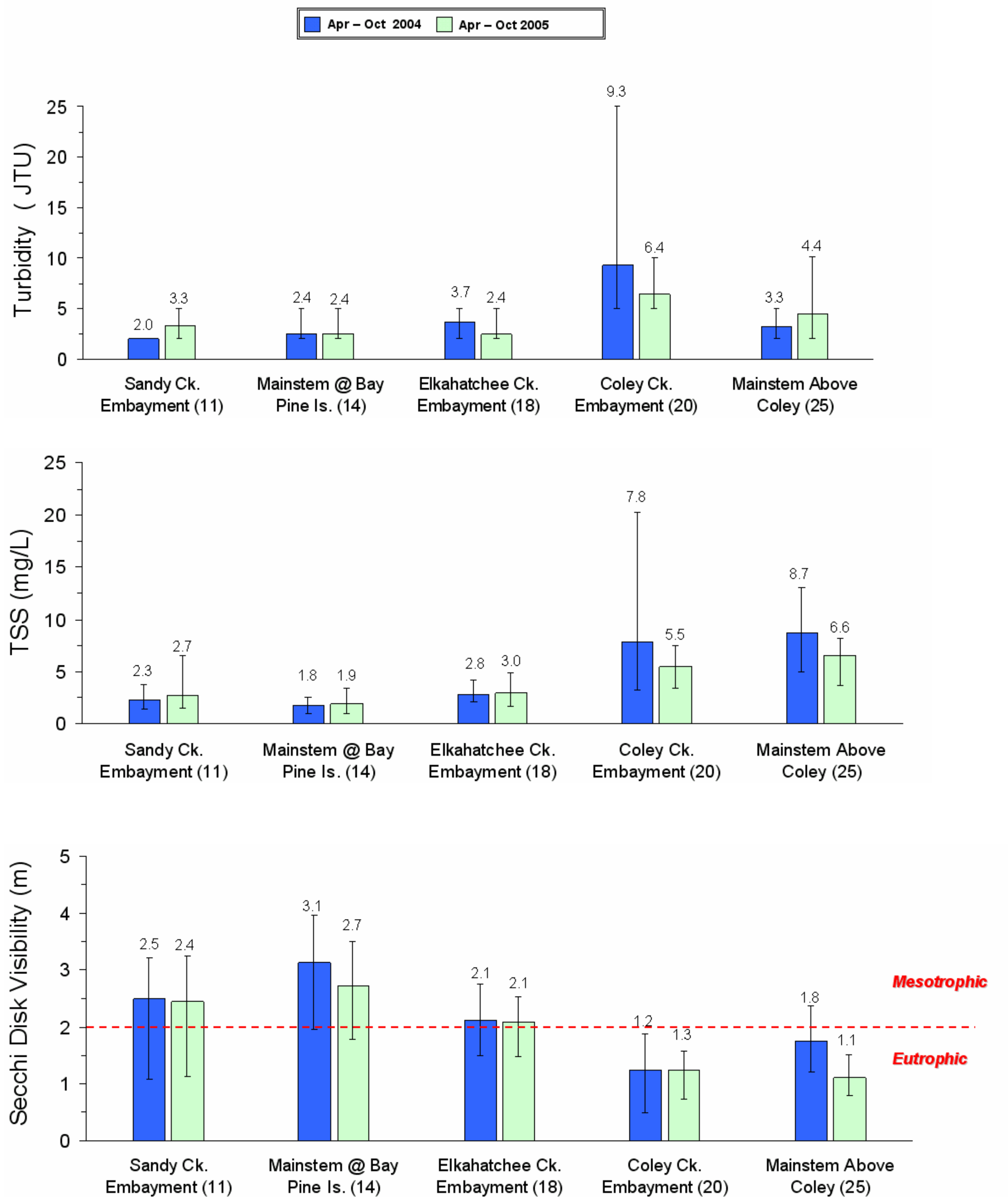


Figure 17. Growing season (April – October) average turbidity, total suspended solids (TSS) and Secchi disk visibility of sites on Lake Martin sampled by Lake Watch of Lake Martin during 2004 and 2005. ADEM and AU TSS data were used for April-July of 2004. The number in parentheses after the site's name is the AU site code. Brackets on bars represent the range (minimum and maximum), values above bars are averages.

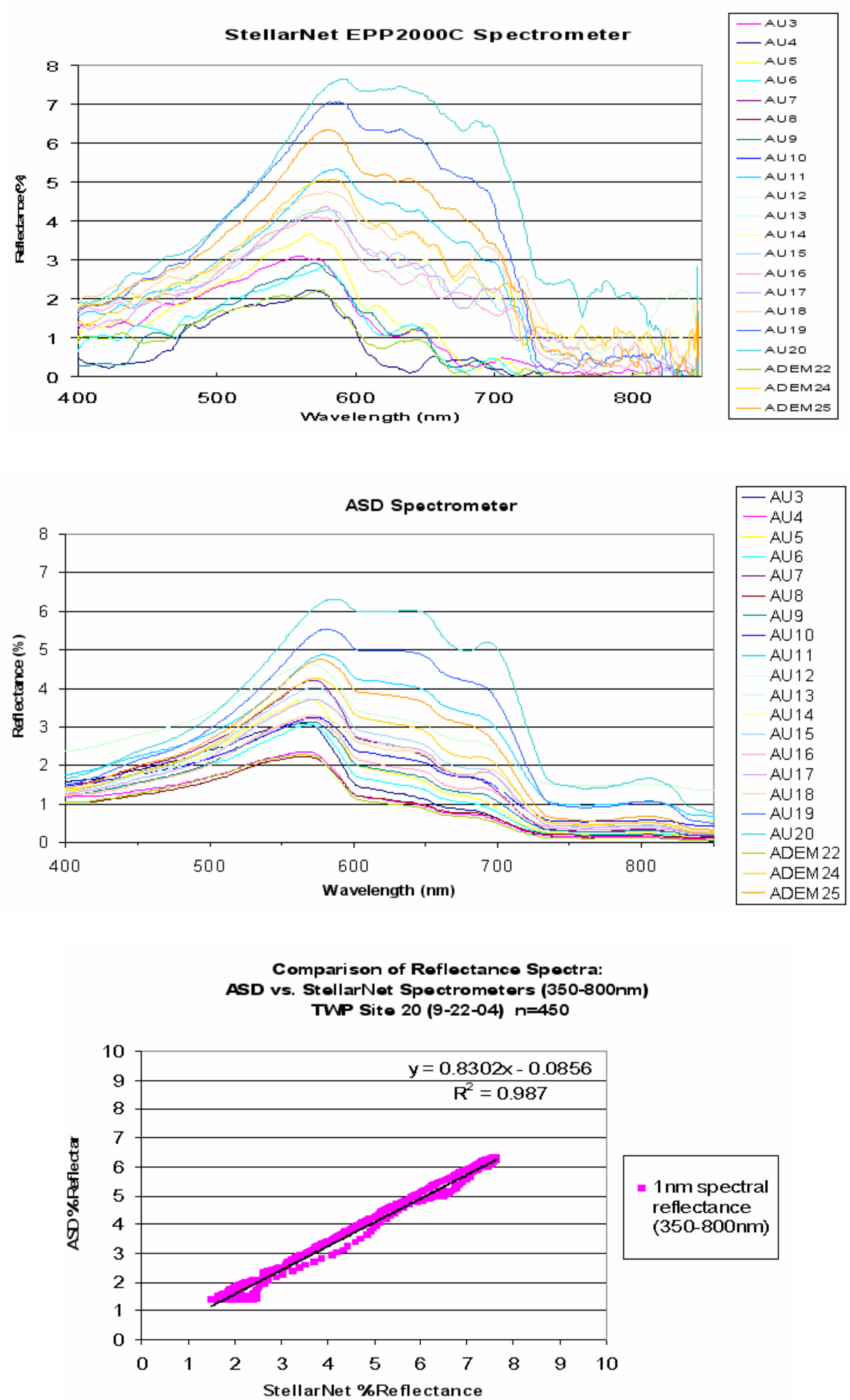


*Figure 18. Side-by-side comparison of the relatively low-cost hyperspectral radiometer of Lake Watch of Lake Martin (StellarNet EPP2000C) and the high-end hyperspectral radiometer of UA (*ASD FieldSpec UV/VNIR) at sample sites on Lake Martin in September, 2004.

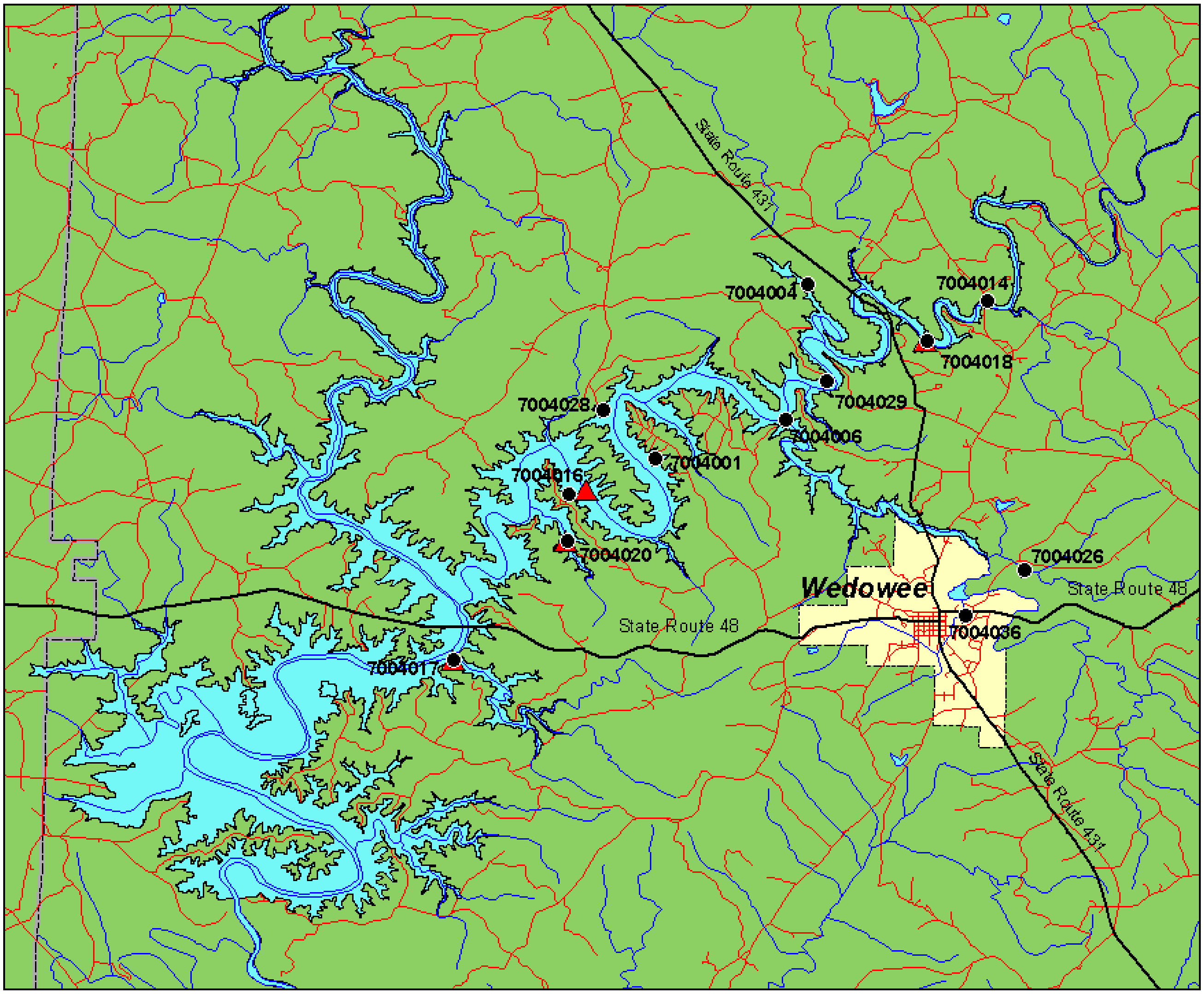


Figure 19. Lake Wedowee Property Owners Association (LWPOA) sample sites (black circles) and coincident AU Standard Methods sites (red triangles) on Lake Wedowee. Site numbers are LWPOA-AWW site codes.

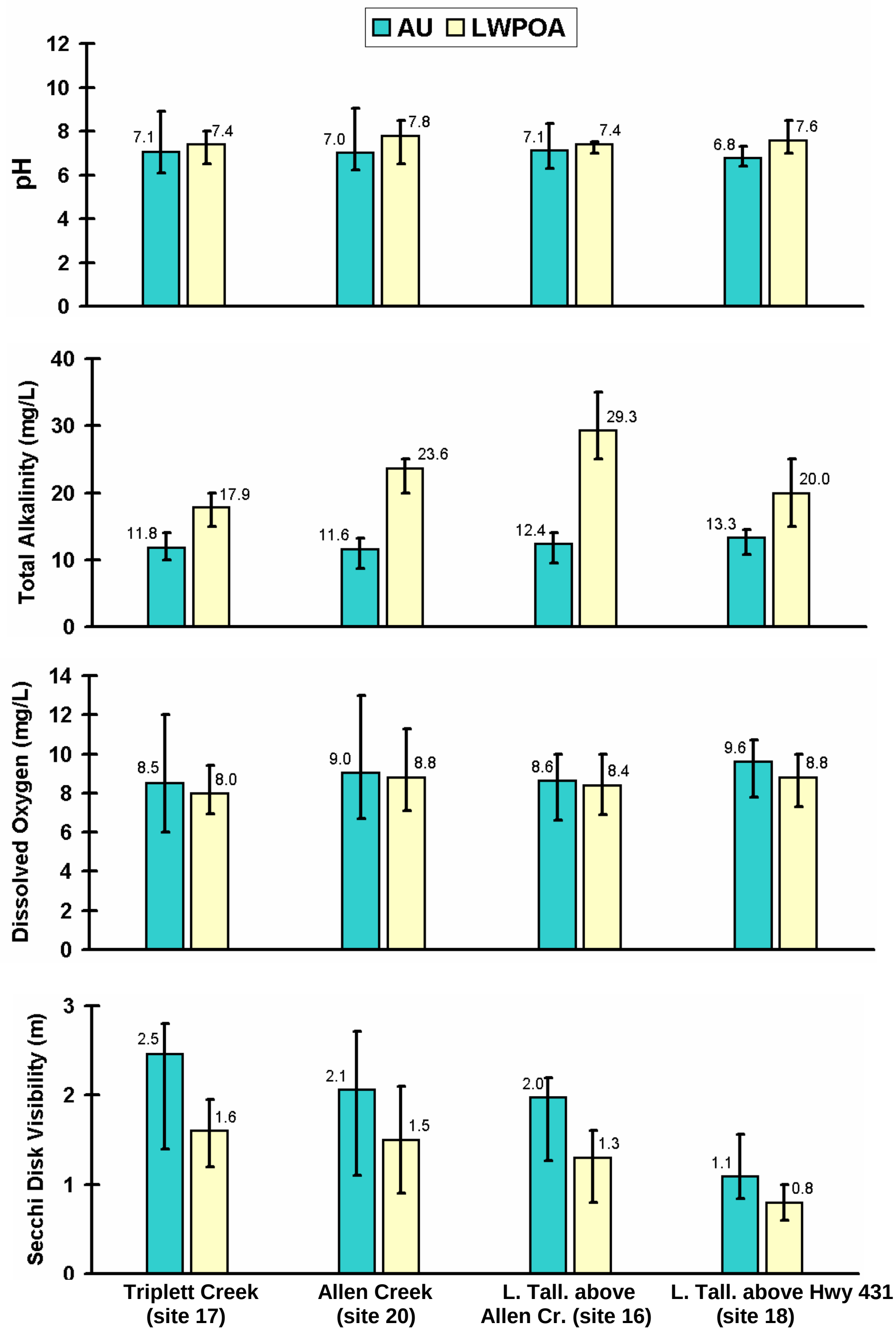


Figure 20. Growing season (April – October) average pH, alkalinity, dissolved oxygen and Secchi disk visibility of four sites on Lake Wedowee sampled by AU Fisheries and Lake Wedowee Property Owners Association during 2005. Site number corresponds to LWPOA site code. Brackets on bars represent the range (minimum and maximum), values above bars are averages.

BIO-ASSESS
STREAM QUALITY ASSESSMENT FORM

Stream Name________________________________ Site (Color of Deck)______________
Describe Location ____
County ________________ Town/City__________________ Date________ Time______
Monitoring Group Name____
Names of team members: Yellow Team____
White Team____
Blue Team ____

MACROINVERTEBRATE TALLY

Letter Code: For Tally ***R = 1 to 3 individuals (Rare)***
C = 4 to 9 (Common)
A = 10 or more (Abundant)

GROUP 1 TAXA	*Letter Code*	GROUP 2 TAXA	*Letter Code*	GROUP 3 TAXA	*Letter Code*
Mayfly		Hellgramite		Aquatic Worm	
Stonefly		Dragonfly		Midge	
Caddisfly		Crane Fly		Pouch Snail**	
Riffle Beetle		Filtering Caddisfly*			
Snail		Crayfish			
		Scud			
		Sowbug			
		Snipe Fly			
		Blackfly			
Number of Taxa =______ Multiply by 3 =______ (Index Value)		Number of Taxa =______ Multiply by 2 =______ (Index Value)		Number of Taxa =______ Multiply by 1 =______ (Index Value)	

* Filtering Caddisflies are in the Family Hydropsychidae (gills on abdomen; most common caddisfly)
** Pouch snails are in the Family Physidae (shell opens to the left; air-breathing snail)

Total Number of Taxa *(Sum of Number of Taxa in Each Group)* ☐

Cumulative Index Value *(Sum of Index Values for Each Group)* ☐

STREAM QUALITY ASSESSMENT :
(Check box corresponding to Cumulative Index Value)

EXCELLENT (>22) ☐ GOOD (17-22) ☐
FAIR (11-16) ☐ POOR (<11) ☐

Figure 21. Bio-assess form developed by Alabama Water Watch for assessing the water quality of a stream through the collection and examination of the stream's resident macroinvertebrate (aquatic insect) community.

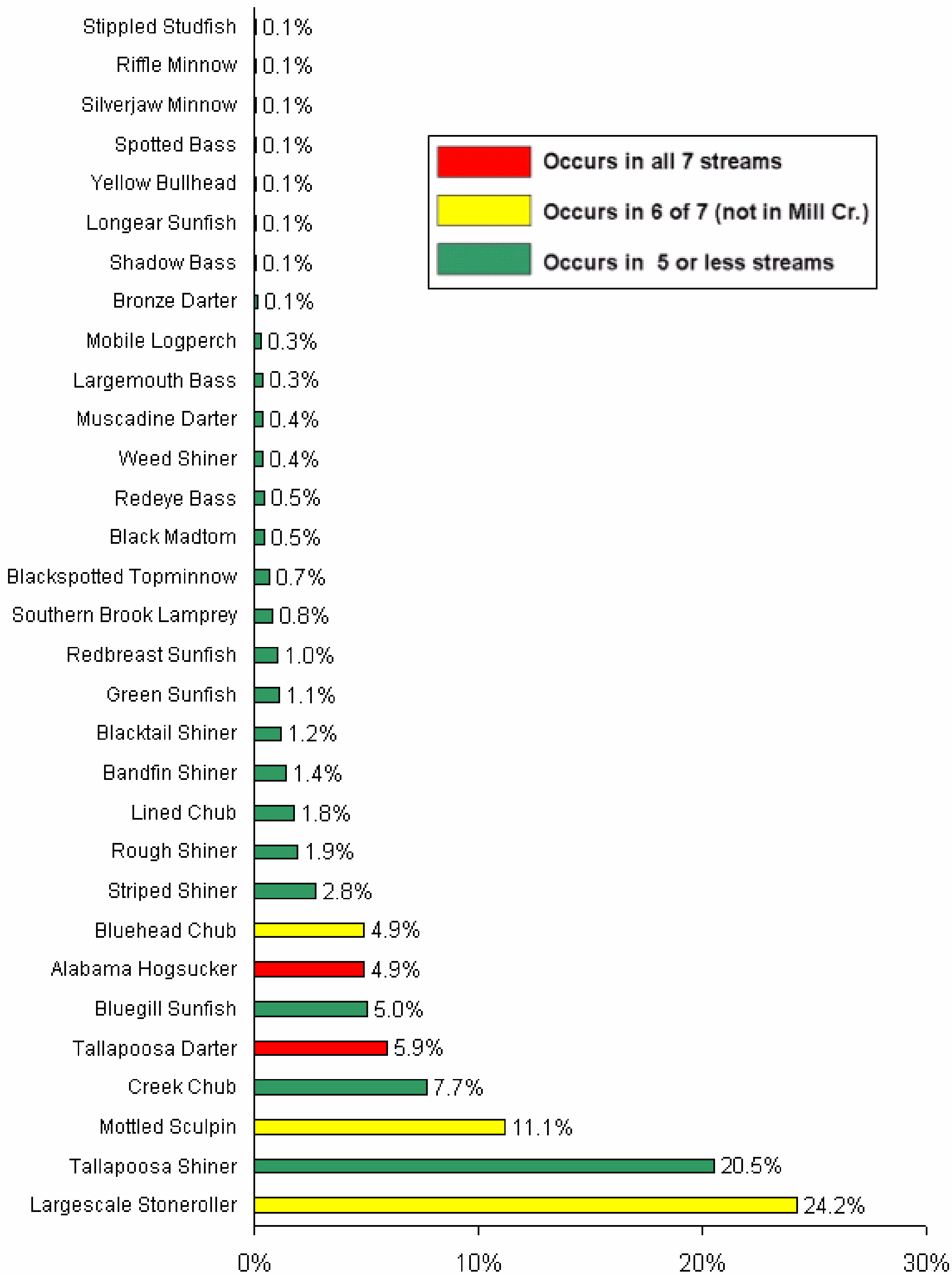


Figure 22. Abundance of fish species expressed as percent of total abundance sampled from seven streams in the Middle and Upper Tallapoosa basins in November-December 2005.

This project is funded by
the Cooperative State Research,
Education and Extension System (CSREES)
of the U.S. Department of Agriculture.

The Cooperative State Research,
Education, and Extension Service (CSREES)
is an agency within the U.S. Department of Agriculture