

**HANDBOOK FOR UNDERGRADUATE
STUDENT RESEARCH**

**Department of Biological and
Environmental Sciences**

Troy University

Troy, AL 36082



Revised August 2009

PREFACE

The purpose of this *Handbook* is to provide guidelines for undergraduates doing research in the Department of Biological and Environmental Sciences at Troy University, and also to provide information to help students with their projects.

This *Handbook* is available online at the Department's Undergraduate Research page (link found on Department home page).

WHY DO RESEARCH?

Deciding to complete a research project is potentially one of the most important decisions that a student can make. What are the benefits of completing a research project?

- Have an enjoyable experience while increasing knowledge of fundamental principles of biology
- Increase understanding of the scientific method
- Develop skills that prepare you for future academic or work experience
- Get to know faculty and other students
- Contribute to the field of biology
- Possibly attend meetings and conferences and publish results
- Possibly obtain scholarships or fellowships available to student researchers
- Make a positive impression on graduate schools, medical schools, other professional schools, or future employers
- Decide if a future career in a research-oriented field is appropriate

GETTING STARTED

Once a student decides to participate in undergraduate (UG) research, the student must find a Faculty Supervisor. Students can investigate the areas of expertise and interests of the faculty in the Department of Biological and Environmental Sciences by looking at individual faculty web pages (available at Department home page). Students should then schedule an appointment with the potential Faculty Supervisor to find out if undergraduate research opportunities are available with that faculty member. Each faculty member and project will have different requirements for student academic achievement (GPA), prerequisite coursework, project length, and workload. The Faculty Supervisor will decide whether a student is a match for a particular project based on student background, enthusiasm, and schedule.

Once it is agreed that a student will participate in a particular project, the student must then decide if they would like to sign up for research credit (*Guided Independent Research* BIO 4491, BIO 4492 or *Guided Independent Study* BIO 4493, BIO 4494). [Note: Approval by the Faculty Supervisor is required before a student can enroll in *Guided Independent Research* or *Guided Independent Study*.]

There are advantages and disadvantages for enrolling in BIO 4491-4494. The advantages are: 1) students will tend to have more involvement in the project if taking it for credit and 2) BIO 4491, 4492, 4493, and/or 4494 will appear on college transcripts. The disadvantages are 1) students have to pay tuition for BIO credits and 2) students will be committed to a more regular schedule and have to follow a syllabus of requirements (see Appendices for sample syllabi).

If a student decides to take *Guided Independent Research or Study*, they make arrangements with the Faculty Supervisor and sign up for the class. Students may take BIO 4491 or BIO 4493 for 1-3 hours credit each. If the student wants to continue the project for credit after the first semester, they may sign up for the continuation course, (either BIO 4492 or BIO 4494) for 1-3 credit hours. A maximum of 6 credits is allowed in BIO 4491-4494. Alternatively, the student may choose to continue to participate in the research without receiving additional credit.

THE RESEARCH PROJECT

Good research projects are well-planned and developed before data collection begins. At the beginning of your project, the student meets with the Faculty Supervisor to discuss many aspects of the project, including:

1) Objective

- What are the short term and long term goals, and expected results?

2) Rationale

- What is the experimental approach and reason for conducting the project?

3) Hypothesis/Testing of hypothesis

- What is the hypothesis that is being tested?
- Is your approach suitable for testing your hypothesis?

4) Methods

- What specific methods will be used in the lab/field?
- What background knowledge will you need?
- What will your involvement be in this aspect of the project?

5) Analysis of data

- How will the data be analyzed, examined, and recorded?
- What will your involvement be in this aspect of the project?

6) Timeline for project, weekly schedule.

- How much work will this project involve?
- How many hours per week?
- How long will you be involved with this project?

7) Safety

- Each student should read and sign a Departmental lab safety and/or field safety guidelines sheet before beginning.
- Each student should make him/herself aware of any chemical hazards involved with the project. Talk to your Faculty Supervisor about chemical hazards, read pertinent Material Safety Data Sheets (MSDSs), and follow lab safety guidelines.

- Students should talk to their Faculty Supervisor about personal safety issues, such as avoiding research hours at night and avoiding collections in unsafe locations.
- Students should be aware of current Departmental procedures for chemical storage, disposal, and any laboratory safety issues specific to a Faculty Supervisor's laboratory.

8) Presentation of data

- Will this research be presented at a scientific meeting?
- Are there abstract deadlines that need to be followed?
- Who will write and author publications from this research?

9) Permission

- Student and Faculty Supervisor should obtain appropriate licenses and collection permits
- Project must be approved by the Institutional Review Board

Once the student understands these fundamental principles of research, the project can be designed and research initiated. Keep in mind that UG research is “guided”. All phases of the project are supervised and approved by the Faculty Supervisor.

GENERAL INFORMATION

Ownership of research data and notebook

All data collected in the Department of Biological and Environmental Sciences are the property of Troy University and are administered by the Faculty Supervisor (Professor). All students must maintain a research notebook and other appropriate records of their research data (autoradiographs, computer printouts, computer files, digital photographs, films, programs, specimens, videotapes, etc.), as directed by the Faculty Supervisor. The Faculty Supervisor will provide a laboratory notebook and other data recording materials (film, jump drive, etc.). The notebook serves as a research diary for recording the raw data. The notebook and any other records of the research should always be kept in the

laboratory. All original data and specimens must be provided to the Faculty Supervisor before the student graduates and at the end of the project. Failure to provide the appropriate data and documentation may result in a student receiving an “F” in *Guided Independent Research or Study*, or other appropriate action (such as an academic hold). Data collected during a Troy University UG project may not be presented at any meeting, posted on the internet in any way, or published in any form before or after graduation without the prior written consent of the Faculty Supervisor.

Publication and presentation of data

Data collected from UG research may be published by the Faculty Supervisor in abstracts, conference papers, journal articles, book chapters, reports, and other appropriate means for disseminating data. Further, this data may be presented at conferences or used to support grant applications or any other use deemed appropriate by the Faculty Supervisor.

Authorship for publications

The Faculty Supervisor may include the student as an author on publications resulting from the work if the student contribution is, in the opinion of the Faculty Supervisor, sufficient to merit authorship. Much time and effort is required by the Faculty Supervisor to effectively coordinate and oversee UG student involvement in a project. The Faculty Supervisor develops the research idea; provides instruction regarding techniques, methodologies, and approaches; oversees basic laboratory instruction; and writes or reviews the abstracts and papers resulting from the research. Data obtained from an UG project can be presented or published as an independent project or combined with data from the Faculty Supervisor’s research or with data from other student projects. The order of authorship is an important issue in academia. Authorship and the order of authors in a publication are determined by the Faculty Supervisor. Typically the Faculty Supervisor will be the primary author on publications and reports that include or are derived from UG research. Authorship issues need to be discussed candidly by the student and Faculty Supervisor at the beginning of the project.

Collecting permits and licenses, and University approval

Research requiring collection of organisms, or environmental sampling, needs to be designed to have minimal impact on natural resources. Appropriate Federal, State, or local (including University) permits and licenses for fieldwork and collections have to be obtained prior to data collection. Additionally, permission should be obtained from landowners before collection on private property takes place. If needed, the Faculty Supervisor can assist in obtaining these permits and licenses.

Many Federal, State, and Local agencies require licensing for research involving alcohol, animal care, drugs, endangered species, and radioactive isotopes. In addition, Troy University requires that the Institutional Review Board approve all research projects. Failure to comply with these regulations can result in the loss of a license for the Department or the University. Moreover, the violator may be subject to Federal, State, or Local penalties. Students should check with the Faculty Supervisor to determine whether licenses are necessary.

Professional conduct and plagiarism

Students and faculty are expected to conform to the codes of ethics and conduct established by professionals in their fields. Intentional plagiarism involves copying the work of others and representing it as one's own. Serious breaches of codes of conduct, such as data fabrication, plagiarism, unprofessional conduct, or a disregard for the need to obtain the appropriate licenses, may result in both disciplinary action and a failing grade in *Guided Independent Research or Study*. If the student has questions about codes of ethics, professional conduct, or the proper citation of material, they should ask their Faculty Supervisor.

University reporting requirements (for Faculty Supervisors):

- 1) **All** research projects must be approved by the Institutional Review Board
- 2) A course syllabus must be given to the student at the beginning of the term and must be on file in the Department office (for students taking research for credit. See Appendix I and II for sample formats).

- 3) A final written report must be submitted by the student. This report can be submitted in a variety of formats (printed copy of meeting presentation with summary report, written paper, data notebook with summary report) as determined by the Faculty Supervisor. Copies of this report must be on file in the Department office at the end of the course (for students taking research for credit).
- 4) A Student work agreement is recommended for **all** research projects, whether the student is enrolled in GIS/GIR. This work agreement should be on file with the Departmental office (see appendix III for a sample).

APPENDIX I

(sample syllabus for Bio 4491 & Bio 4492. Faculty should consult Faculty handbook for syllabus essentials)



BIO 4491 – Guided Independent Research, Section XXXX, 1 Credit Fall 2007

Location: 201 MSCX

Time: Arranged

Text: None, though student must read, follow, and understand the *Handbook for Undergraduate Research*

(<http://troy.troy.edu/artsandsciences/biologicalsciences/ugresearch.html>)

Course Instructor: Dr. S C. Landers 210A MSCX 670-3661. slanders@troy.edu

Office Hours: Arranged

Student: John Smith

Research project and course learning objectives for John Smith: Project title: Morphological analysis of the trematode parasite *Alloglossidium*. The student will learn how to conduct research, record data, and produce a scientific presentation. Specifically the project involves cutting thick plastic sections of the trematode *Alloglossidium*, a parasite of grass shrimp. The material will be provided to the student along with instructions on proper microtomy technique. The goal is to collect data on the parasite-host interface and to determine the extent of tissue damage in the host kidney caused by the parasite. Control uninfected kidneys will be sectioned for comparative information. This data will be used to create a poster or a talk that the student will present at a regional meeting or at a Troy University BBB meeting.

Course description, objectives: Undergraduate research with attention to critical evaluation of research techniques, methods and procedures.

Desired competencies: Students will develop independence in the laboratory regarding their research project and will learn how to write a scientific abstract.

Method of instruction: Individual instruction in the laboratory.

Prerequisites: Junior or senior standing with a minimum overall GPA of 3.0, permission of guiding professor, approval of the Department Chair and Dean. A written request must be submitted to the Department Chair at least two weeks in advance of the term the research is to be undertaken; application forms are available in University Records. GIR may be taken only in the applicant's major or minor field.

Requirements: Students must follow University regulations concerning eligibility. Students are required to work on their research project for a minimum of **3 hours/week per credit hour**. At the end of the course a project report/data report must be submitted.

Important dates:

Aug 19 Last day for to WD w/o owing full tuition, drop w/o financial penalty

Aug 19 Last day to add a course

Sept 3rd Labor Day Holiday

Oct 19 Last day to withdraw or drop without academic penalty

Nov 12 Holiday

Nov 24-26 Thanksgiving Holiday

Dec. 1st- Due date for ASB abstracts

Grading:

1) Attendance, work effort, performance, and adherence

to lab/ field safety rules:

50 pts

(25 given before drop date, remaining 25 given at the end of the course)

2) Submission of an acceptable scientific abstract (Due Dec 1st)

50 pts

3) Submission of laboratory data and preparation of either an oral

(powerpoint) or poster presentation (preliminary or final, as instructed)

50 pts

Total

150 points

Grading scale: A \geq 90%, B \geq 80%, C \geq 70%, D \geq 60%, F < 59.9%.

Course policies:

1) Attendance. Attendance and participation is required. Due to the nature of research, your hours may change to accommodate the research goals. If you are habitually late or absent from announced lab work times, the instructor may assign you a grade of FA and reassign your project to another student. Exceptions will be made if you can provide a University approved excuse (note from physician, official university function, illness in immediate family) for your missed lab dates.

2) Attendance and work effort grade. Your instructor will provide you with a grade before the drop date.

3) Research paper/data report. Specific requirements are available from your Faculty Supervisor. **Students are required to hand in a final written report.**

4) Americans with Disabilities Act. Any student whose disabilities fall within ADA must inform the instructor at the beginning of the term of any special needs or equipment necessary to accomplish the requirements for this course.

5) Additional Services. Students who have or may be dealing with a disability or learning difficulty should speak with the instructor, contact the Office of Adaptive Needs Program (215 Adams Center), or call 670-3220/3221. Various accommodations are available through the Adaptive Needs Program.

6) Lab Safety. Absolutely no eating, drinking or use of tobacco in the lab. All students must read, understand, and sign the Departmental lab safety rules and/or field safety rules handouts. Additional laboratory or field rules may be given to the student and must be followed.

7) Incompletes. Will be given only in special circumstances. See Bulletin for guidelines.

8) All students must read the current edition of "Handbook for Undergraduate Student Research" available from their Faculty Supervisor or from the Dept. Biol. Env. Sci., *prior* to beginning the course.

9) Cheating or professional misconduct: Will result in student dismissal from the class and possible University disciplinary action.

10) This syllabus is subject to change without notice. Students will be informed of any changes at the earliest possible date.

APPENDIX II

(sample syllabus for Bio 4493 & Bio 4494. Faculty should consult Faculty handbook for syllabus essentials)



BIO 4493 – Guided Independent Study, Section XXXX, 1 Credit **Fall 2007**

Location: 201 MSCX

Time: Arranged

Text: None, though student must read, follow, and understand the *Handbook for Undergraduate Research*

(<http://troy.troy.edu/artsandsciences/biologicalsciences/ugresearch.html>)

Course Instructor: Dr. S C. Landers 210A MSCX 670-3661. slanders@troy.edu

Office Hours: Arranged

Student: John Smith

Research project and course learning objectives for John Smith: Project title: Morphological analysis of the trematode parasite *Alloglossidium*. The student will learn how to conduct research, record data, and produce a scientific presentation. Specifically the project involves cutting thick plastic sections of the trematode *Alloglossidium*, a parasite of grass shrimp. The material will be provided to the student along with instructions on proper microtomy technique. The goal is to collect data on the parasite-host interface and to determine the extent of tissue damage in the host kidney caused by the parasite. Control uninfected kidneys will be sectioned for comparative information. This data will be used to create a poster or a talk that the student will present at a regional meeting or at a Troy University BBB meeting.

Course description, objectives: Supervised study through internship, field or laboratory projects, guided readings, creative endeavors, or achievement in specific skills.

Desired competencies: Students will develop independence in the laboratory regarding their research project and will learn how to write a scientific abstract.

Method of instruction: Individual instruction in the laboratory.

Prerequisites: Junior or senior standing, permission of guiding professor, approval of the Department chair and Dean. A written request must be submitted to the Department Chair at least two weeks in advance of the term in which the study is to be undertaken; application forms are available from University Records.

Requirements: Students must follow University regulations concerning eligibility. Students are required to work on their research project for a minimum of **3 hours/week per credit hour**. At the end of the course a project report/data report must be submitted.

Important dates:

Aug 19 Last day for to WD w/o owing full tuition, drop w/o financial penalty

Aug 19 Last day to add a course

Sept 3rd Labor Day Holiday

Oct 19 Last day to withdraw or drop without academic penalty

Nov 12 Holiday
 Nov 24-26 Thanksgiving Holiday
 Dec. 1st - Due date for ASB abstracts

Grading:

1) Attendance, work effort, performance, and adherence to lab/ field safety rules: (25 given before drop date, remaining 25 given at the end of the course)	50 pts
2) Submission of an acceptable scientific abstract (Due Dec 1 st)	50 pts
3) Submission of laboratory data and preparation of either an oral (powerpoint) or poster presentation (preliminary or final, as instructed)	50 pts
Total	150 points

Grading scale: A \geq 90%, B \geq 80%, C \geq 70%, D \geq 60%, F < 59.9%.

Course policies:

- 1) Attendance. Attendance and participation is required. Due to the nature of research, your hours may change to accommodate the research goals. If you are habitually late or absent from announced lab work times, the instructor may assign you a grade of FA and reassign your project to another student. Exceptions will be made if you can provide a University approved excuse (note from physician, official university function, illness in immediate family) for your missed lab dates.
- 2) Attendance and work effort grade. Your instructor will provide you with a grade before the drop date.
- 3) Research paper/data report. Specific requirements are available from your Faculty Supervisor. **Students are required to hand in a final written report.**
- 4) Americans with Disabilities Act. Any student whose disabilities fall within ADA must inform the instructor at the beginning of the term of any special needs or equipment necessary to accomplish the requirements for this course.
- 5) Additional Services. Students who have or may be dealing with a disability or learning difficulty should speak with the instructor, contact the Office of Adaptive Needs Program (215 Adams Center), or call 670-3220/3221. Various accommodations are available through the Adaptive Needs Program.
- 6) Lab Safety. Absolutely no eating, drinking or use of tobacco in the lab. All students must read, understand, and sign the Departmental lab safety rules and/or field safety rules handouts. Additional laboratory or field rules may be given to the student and must be followed.
- 7) Incompletes. Will be given only in special circumstances. See Bulletin for guidelines.
- 8) All students must read the current edition of "Handbook for Undergraduate Student Research" available from their Faculty Supervisor or from the Dept. Biol. Env. Sci., *prior* to beginning the course.
- 9) Cheating or professional misconduct: Will result in student dismissal from the class and possible University disciplinary action.
- 10) This syllabus is subject to change without notice. Students will be informed of any changes at the earliest possible date.

APPENDIX III

Sample Work Plan For BIO 4491, 4492, 4493, and 4494

(recommended for **all** student research projects, including those not enrolled for credit)

**Work Plan/Agreement**

Fall 2007

Student: John Smith**Topic:** Morphological analysis of the trematode parasite *Alloglossidium*.**Supervisor:** Dr. Stephen Landers

Dr. Landers will act as Faculty Supervisor on this project. He will provide laboratory space and instruction for this project and will oversee the research.

Objectives: (1) To provide the student with research experience and training in data collection and presentation (2) to provide the student will experience in conducting literature search, and (3) to teach the student how to write a scientific abstract.

Nature of the problem: The freshwater grass shrimp, *Palaemonetes kadiakensis*, harbors the renal parasite *Alloglossidium renale*. It has been rarely reported and a new analysis of its prevalence and pathological effects will be a valuable scientific contribution.

Work Plan:

Part 1 (Fall 2007) – Review of the literature of *Alloglossidium* infections. Dr. Landers will collect the shrimp locally. John Smith will fix and stain trematodes collected from shrimp, and make plastic sections of tissue. Material collected prior to Fall 2007 will be available for analysis also. Data from whole mount stained worms and sectioned worms will be used to study species characteristics and pathological effects on the host.

Part 2 (Spring 2008) – Attend the Spring 2008 ASB meeting (April 16-19, Spartanburg, SC) and present research. The presentation can be either a talk or a poster presentation, as approved by Dr. Landers. Costs for the meeting will be the responsibility of the student (travel to the meeting may be provided by TU). The student should budget for hotel and food for 4 days in addition to registration for the meeting. Student registration was \$65 last year and student membership to ASB was \$15.

Work Effort: The student researcher agrees to a weekly effort of 3 hrs/week. Holidays and final exam periods will not be counted.

The parties involved agree to the **Work Plan** outlined above as indicated by the signatures below. Additionally, the student certifies that he/she has received and will follow the rules outlined in the current edition of the **Handbook for Undergraduate Student Research**.

John Smith _____ Date _____

Stephen Landers, Ph.D. _____ Date _____

APPENDIX IV

Checklist for supervisors of undergraduate research.

1) For UG Projects not involving GIS/GIR credit use the 5 box checklist (left margin only)

2) For GIS/GIR Projects use the 9 box checklist (all boxes)

- Work plan/work agreement with student
- Student receives UG research handbook
- Obtain appropriate permissions, collecting licenses, and Institutional Review Board approval.
 - Application to enroll in GIS/GIR
 - Create GIS/GIR course section(s)
- UG research meeting at start of semester
 - Syllabus given to student and Department at beginning of semester
 - Follow all TU course rules (attendance grades, final grades)
 - Hand in a final report, presentation, etc. to the Department.
- Report all submitted and published abstracts, papers, and other publications to the Department.

APPENDIX V.

Publications and presentations of research involving Troy University Biology undergraduates (undergraduate students in bold).

Journal Articles, Conference Papers, Abstracts and Technical Reports: 2009

- Barron, J.K.**, and Landers, S.C. 2009. Priapulida and Loricifera from the Gulf of Mexico. *Southeastern Biology* 56: 331.
- Berry, B.M.**, and Gaston, J.L. Graphic organizers used as tools to differentiate and enhance science instruction in the classroom. *Southeastern Biology* 56: 366.
- Biebinger, B.**, and **Hobgood, K.** 2009. The survey of antibiotic resistance to commonly used antibiotics in the healthcare setting. *Southeastern Biology* 56: 385.
- Braune, S.E.**, and Landers, S.C. 2009. Cross-infestation studies of apostome ciliated protozoa. *Southeastern Biology* 56: 345-346.
- Jackson, S.** 2009. Heat shock protein interactions with the androgen receptor. *Southeastern Biology* 56: 374.
- Jones, V.** 2009. Survey of air microbes in student residences at Troy University. *Southeastern Biology* 56: 386.
- Herring, C.** 2009. Survey of oral flora among traditional age college students, ages 19-24. *Southeastern Biology* 56: 385-386.
- Leverett, L.**, and Woods, M. 2009. The genus *Indigofera* (Fabaceae) in Alabama. *Southeastern Biology* 56: 362.
- Lyle, S.D.**, Alami, M.H., Gaston, J., Koigi, R.N., **Wotawa, A.M.**, and Billington, N. 2009. Management implications of genetic variation in walleye populations. *Southeastern Biology* 56: 287-288.

2008

- Jones, R.** and Landers, S.C. 2008. Morphological analysis of the trematode parasite *Alloglossidium*. *Southeastern Biology* 55: 230-231.
- Key, J.** and Woods, M. 2008. The genus *Rhynchosia* (Fabaceae) in Alabama. *Southeastern Biology* 55: 354.
- Koigi, R.N., Gaston, J., Billington, N., **Creech, R.E.**, **Wotawa, A.M.**, and **Lyle, S.D.** 2008. Hybridization between walleye and sauger. *Journal of the Alabama Academy of Science* 79: 78-79.
- Lyle, S.** and Billington, N. 2008. Genetic variation in walleye populations. *Journal of the Alabama Academy of Science* 79: 78.
- Lyle, S.**, Billington, N., Koigi, R.N., Gaston, J., **Wotawa, A.M.**, **Creech, R.E.**, and **Rasuck, C.** 2008. Genetic variation in walleye and sauger populations determined by protein electrophoresis. *Southeastern Biology* 55: 238-239.
- Smith, J.L.**, Gaston, J.L., and Ash, C. 2008. Sudden cardiac death and the pre-participation screening of student athletes at Troy University. *Journal of the Alabama Academy of Science* 79: 128-129.
- Stephens, R.G.** and Blankenship, L.A. 2008. Antibiotic sensitivity and resistance survey among bacteria isolated from aerobic digest from a wastewater treatment plant *Journal of the Alabama Academy of Science* 79: 88-89.
- Wotawa, A.M.** and Billington, N. 2008. Mitochondrial DNA markers for identifying southern and northern strains of Walleye. *Journal of the Alabama Academy of Science* 79: 81.
- Wotawa, A.M.** and Billington, N. 2008. Elucidation of genetic markers for distinguishing between the northern and southern walley strains in Alabama via PCR-RFLP analysis. *Southeastern Biology* 55: 238.

2007

- Barnes, J.** 2007. Wastewater impacts on yeast: analysis of the *Saccharomyces* genome deletion library in response to effluent from the Troy Waste Water Treatment Facility. *Southeastern Biology* 54: 349.
- Barr, A. M.**, and Billington, N. 2007. Hybridization between sauger and walleye. *Journal of Alabama Academy of Science* 78: 104-105.
- Barr, A.M.**, Koigi, R.N., Gaston, J., **Creech, R.E.**, and Billington N. 2007. Hybridization between walleye and sauger determined by protein electrophoresis. *Southeastern Biology* 54: 232.
- Bell, B.L.**, and Landers, S.C. 2007. Endocytosis and digestion in the parasitic dinoflagellate *Haplozoon*. *Southeastern Biology* 54: 322-323.
- Billington, N., Koigi, R.N., Franckowiak, R. P., Sloss, B. L., **Xiong, J.**, and Gardner, W. 2007. Population genetic structure of sauger in the upper Missouri River system. *Southeastern Biology* 54: 231.
- Koigi, R.N., Billington, N., **Xiong, J.**, Sloss, B.L., Franckowiak, R., and Gardner, W. 2007. Genetic structure of Montana sauger populations. *Journal of Alabama Academy of Science* 78: 103.
- Lyle, S.**, Gaston, J., **Barr, A.M.**, Koigi, R.N., **Creech, R.E.**, and Billington, N. 2007. Genetic variation in sauger and walleye determined by protein electrophoresis. *Journal of Alabama Academy of Science* 78: 103-104.
- McHugh, R.** 2007. Assessing transcription termination levels in replication deficient strains of *Saccharomyces cerevisiae*. *Southeastern Biology* 54: 349.
- Sheffield, D.** 2007. Impact of wastewater effluent on the growth, morphology, and gene expression of *Saccharomyces cerevisiae*. *Southeastern Biology* 54: 350.
- Stewart, J.L.**, Witmer, P.L., **McKenzie, A.**, Hodges, K., and Stewart, P.M. 2007. Assessment of fish assemblages upstream and downstream of unpaved road stream crossings in two Choctawhatchee River sub-watersheds. *Journal of Alabama Academy of Science* 78: 99.

2006

- Barr, A.** and Billington, N. 2006. Protein electrophoretic distribution of genetic variation in sauger populations. *Journal of the Alabama Academy of Science* 77: 50
- Barr, A.**, R. N. Koigi, **R. E. Creech**, J. Gaston, and N. Billington. 2006. Genetic variation in sauger populations determined by protein electrophoresis. *Southeastern Biology* 53: 165.
- Billington, N., R. N. Koigi, **A. M. Barr**, J. Gaston, **R. E. Creech**, and **J. Xiong**. 2006. Use of isozyme markers to document genetic variation in sauger. *Gene Families and Isozymes Bulletin* 39: 10.
- Cho, I.K.**, and Magrath, C. 2006. Microarray analysis of lead treated *Saccharomyces cerevisiae*. *Journal of the Alabama Academy of Science* 77: 69
- Cho, Y.**, **Bai, D.**, and Magrath, C. 2006. Northern blot analysis of differentially induced transcription Termination reporter genes. *Journal of the Alabama Academy of Science* 77: 52
- Ezell, P. T., **B. M. Coale**, **J. M. Miller**, and N. Billington. 2006. Comparison of Trophic State Index (TSI) for Southeast Alabama ponds. *Southeastern Biology* 53: 155.
- Gaston, J., R. N. Koigi, **R. E. Creech**, P. T. Ezell, and N. Billington. 2006. Hybridization and introgression between sauger and walleye determined by protein electrophoresis. *Journal of the Alabama Academy of Science* 77: 52
- Koigi, R. N., **J. Xiong**, N. Billington, and W. Gardner. 2006. Genetic variation in Montana sauger and hybridization with walleye. *Journal of the Alabama Academy of Science* 77: 53
- Harris, E.S.** and Landers, S.C. 2006. Survey of protists from lakes and ponds at Troy University. *Southeastern Biology* 53: 278-279.
- Harris, E.S.** and Landers, S.C. 2006. Rotifer diversity in ponds and lakes at Troy University. *Journal of the Alabama Academy of Science* 77: 48
- Johnson, M., Parker, M., **Anderson, J.** and Gaston, J. 2006. Graphic organizers as tools to differentiate science instruction in the secondary classroom. *Journal of the Alabama Academy of Science* 77: 86
- McHugh, R.**, Bhattarai, S., Magrath, C., Reynolds, P., and Whatley, A. 2006. A putative cytochrome p450 mRNA induced by exposure to waste water treatment efflux in channel catfish. *Southeastern Biology* 53: 162
- McHugh, R.**, Bhattarai, S., Magrath, C. and Whatley, A. 2006. DNA sequence analysis of a putative cytochrome p450 from waste water treated channel catfish. *Journal of the Alabama Academy of Science* 77: 58
- Miller, J. M.**, and P.M. Stewart. 2006. Variations of life history among burrowing crayfish in the

- Cambarus digenes* (Girard) complex. Journal of the Alabama Academy of Science 77: 51
- McCall, A., **Aplin, J. Robinson, W.**, and Stewart, P.M. 2006. Structure and function of fish assemblages in beaver ponds of the Choctawhatchee-Pea and Conecuh River watersheds, Alabama. Journal of the Alabama Academy of Science 77: 50
- Nahar, P., **Flinn, K.**, Noble, J. and Magrath, C. 2006. Transcription termination capacity of intergenic regions from *S. cerevisiae*. Journal of the Alabama Academy of Science 77: 58
- 2005**
- Billington, N., **Creech, R. E.**, Gaston, J., Ezell, P. T. and Brooks, R. C. 2005. Genetics of walleye and sauger in Lake Diefenbaker, 2004. Technical Report of Department of Biological and Environmental Sciences, Troy University to Saskatchewan Environment, 31 March, 35 pp.
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