INTERNSHIP IN CROP, SOIL, AND ENVIRONMENTAL SCIENCE
CSES 462V

The internship program is based upon the principle that what students learn in the workplace can be a valuable supplement to what they learn in the classroom. By combining work and study, students gain greater insight into each and may be better prepared for employment in their chosen careers. The CSES internship is designed to fit needs of the individual student, but, for full credit, the student must meet minimal requirements listed below and the internship must have a substantive academic component to it beyond simply going to work for someone. In cooperation with an employer, the course will be supervised by an internship committee made up of three instructors from the CSES faculty representing Crop Management, Environmental, Soil, and Water Science, and Weed Science. At least two of the instructors will be located at UA-Fayetteville.

Requirements for academic credit:

1. Learning objectives for an internship project will be initially agreed upon by a CSES internship committee, an employer (sponsor), and the student. A written pre-proposal is required to initiate the internship and must be approved by the committee prior to the conclusion of the spring semester if it is a summer internship. An outline of what the pre-proposal should include and an example of a well-prepared pre-proposal are attached. *Only after the pre-proposal has been approved by the committee* will the student be enrolled in CSES 462V. If it is anticipated that the student will not complete all of the requirements prior to the end of a term (Spring/Fall/Summer), the student may postpone enrolling in the internship course until the following term.

2. All students enrolling in the internship course for a given term will meet together as a group with one or more of the internship committee instructors prior to the term of enrollment to discuss the requirements of the internship and desired timeline for completing the various requirements of the internship.

3. After the project is approved by the internship committee, the student will work directly with one instructor who is a member of the internship committee. The student must submit a full proposal to the instructor within two to three weeks after beginning employment for review and approval by the internship committee. The student should work with the instructor to develop an appropriate format for the proposal, particularly if the academic component of the internship is something other than a mini-research project. An outline to follow for the proposal format is attached along with an example of a well-prepared proposal.

4. Upon completion of the internship employment, the student must submit a final written report to the instructor. This report will be distributed to the internship committee for review and evaluation. The final report should follow a similar format as the internship proposal. An example of a well-prepared final report is attached.

5. In addition to the final written report, the student will make an oral presentation which summarizes his/her internship to the CSES Colloquium class, CSES Seminar, the internship committee, or another appropriate audience to be decided upon by the committee and the student.

6. The internship committee will evaluate the student's performance and determine the letter grade for the course based upon fulfillment of all requirements. The semester credit hours available for internship will be a minimum of 1 to a maximum of 3 hours.

Enrollment in the internship course (CSES 462V) is by instructor's consent only. Therefore, any student wishing to enroll in the internship class must contact one of the internship committee members listed below for a copy of all current requirements and approval to enroll.

<u>Internship Committee</u>

Crop Management: Dr. Larry C. Purcell
Altheimer Laboratory
Phone: 575-3983
Email: lpurcell@uark.edu

Weed Science: Dr. Jason K. Norsworthy
Altheimer Laboratory
Phone: 575-8740
Email: jnorswor@uark.edu

Environmental, Soil, and Water Science: Dr. Kristofor R. Brye
123 AGRI Building
Phone: 575-5742
Email: kbrye@uark.edu

REQUIREMENTS FOR INTERNSHIP (CSES 462V)

Before the student can enroll in the course (CSES 462V), he/she must prepare and submit a pre-proposal (see attached outline and example provided) to the internship committee for approval. Once the pre-proposal is approved and the student begins employment, the student must submit a full proposal (see attached outline and sample provided) explaining in detail what academic activities will be completed as part of the internship. The full proposal is due to the internship instructors no later than three (3) weeks into the job/internship. Frequently, a student is hired by a firm, agency, or company and has little if any idea what activities will be available to fulfill the academic requirements for the internship. The pre-proposal and subsequent proposal requirements allow the student to have a realistic time frame in which to assess the academic component of the internship and report to his/her internship advisor. Preparation of both the pre-proposal and proposal should be done in consultation with the instructor for proper formatting and effective communication of the academic component of the internship and to facilitate preparation of the final report.

The course grade will be assigned based upon the following distribution:

Pre-proposal	10%
Proposal	20%
Oral Report	35%
Final Written Report	35%

Academic Honesty

As a core part of its mission, the University of Arkansas provides students with the opportunity to further their educational goals through programs of study and research in an environment that promotes freedom of inquiry and academic responsibility. Accomplishing this mission is only possible when intellectual honesty and individual integrity prevail.

The University policy for Academic Honesty will be followed in this class. It is our intention that no student will receive any credit for this class if a dishonest act (i.e., plagiarism) on his/her part is evident relative to the work in this class.

Each University of Arkansas student is required to be familiar with and abide by the University's Academic Integrity Policy which may be found at http://provost.uark.edu/. Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor.

INTERNSHIP PRE-PROPOSAL FORMAT

CSES 462V (1-3 hours)
K.R. Brye, J.K. Norsworthy, L.C. Purcell

A. **Title:** Provide a brief, clear, specific designation of the subject.

B. **Submitted By:** List full name, summer address, phone number, and email address where you can be contacted.

C. **Company Sponsor:** List company's full name, immediate supervisor's name, address, and phone #.

D. **Date of Pre-proposal Submission to Committee:**

E. **Dates of Internship:** Indicate the starting and ending dates

F. **Credit Hours:** List the number of semester hours of credit for which you are enrolling (1 to 3 hrs).

G. **Brief Description of Proposed Activities:** In 2-3 sentences, briefly describe what you plan to do. Though specifics might not be possible at the time the pre-proposal is prepared and submitted, students should at least briefly describe how the internship will extend beyond a summer job and what the student anticipates would be the academic product or documentation of their internship (i.e., a term paper, weekly log of activities/responsibilities, or a research component).

EXAMPLE PRE-PROPOSAL

Internship Pre-Proposal

CSES 462V (1-3 hours)

A. Title: Comparison of Ozark Bass Found in Upper White River Basin to Previous Data on Other Rock Bass Species Based on Age and Size

B. Submitted By: Name
Mailing address
Phone number
Email address

C. Sponsor: Individual's name
Company/Organization
Address
Phone number

D. Date of Submission to Committee: 3 May, 2013

E. Dates of Internship: May 13 through August 15, 2013

F. Credit Hours Requested: I am requesting three hours of credit for my upcoming summer 2013 internship experience. I will be working approximately 40 hours per week with the Fisheries Department of the Arkansas Game and Fish Commission in Mountain Home, Arkansas. During the fall semester of 2013, I will give a presentation at the University of Arkansas about my experiences and research opportunity.

G. Brief Description of Proposed Activities: During my internship, I will learn techniques in fish sampling, fish aging, and data collection. Fish sampling techniques will include electrofishing and gill and hoop netting, among others. I will assist with stream habitat and restoration projects through the Cold Water Habitat and Stream Team programs. My specific research project will be comprised of estimating size and age distribution of Ozark Bass (a species of Rock Bass endemic to the Upper White River Basin) on Crooked Creek, the Buffalo River, and other small streams and recording the measured information to compare to previous data from other Rock Bass species. This will be beneficial in the future to determine catch limitations and gage Ozark Bass's viability in the White River Basin. I'll also be measuring prominent water quality indicators.

INTERNSHIP PROPOSAL FORMAT
CSES 462V (1-3 hours)
K.R. Brye, J.K. Norsworthy, L.C. Purcell
***** DUE BY 3 WEEKS AFTER BEGINNING EMPLOYMENT/INTERNSHIP *****

SECTION 1 (Pre-proposal; this will be the first page of the full proposal)

A. **Title:** Provide a brief, clear, specific designation of the subject.
B. **Submitted By:** List full name, summer address, phone number, and email address.
C. **Company Sponsor:** List company's full name, immediate supervisor's name, address, and phone #.
D. **Date of Pre-proposal Submission to Committee:**
E. **Dates of Internship:** Indicate the starting and ending dates
F. **Credit Hours:** List the number of semester hours of credit for which you are enrolling (1 to 6 hrs).
G. **Brief Description of Proposed Activities:** In 2-3 sentences, briefly describe what you plan to do. Though specifics might not be possible at the time the pre-proposal is prepared and submitted, students should at least briefly describe how the internship will extend beyond a summer job and what the student anticipates would be the academic product or documentation of their internship (i.e., a term paper, weekly log of activities/responsibilities, or a research component).

SECTION 2 (start this section at the top of page 2; may be longer than 1 page)

H. **LITERATURE REVIEW:** This section should consist of a summary of knowledge about the general topic of the internship. Pertinent publications, with emphasis on their relationship to the proposed project, should be cited and described.

I. **JUSTIFICATION:** This should describe the importance/necessity of the work in this area.

SECTION 3 (start this section at the top of a new page after SECTION 2; may be longer than 1 page)

J. **OBJECTIVE(S):** A clear, complete, and logically arranged statement of the specific aims of the proposed project should be articulated.

K. **METHODS AND MATERIALS/PROCEDURES:** A statement of the essential working plans and methods to be used in attaining each of the stated objectives should be described. Procedures should correspond to the objectives and follow the same order. Procedures should include items such as: the sampling plan, experimental design, and analyses anticipated (see attached example).

SECTION 4 (start this section at the top of a new page after SECTION 3; may be longer than 1 page)

L. **REFERENCES:** An alphabetical listing of all publications referenced in the proposal constructed in a consistent and complete format.

EXAMPLE PROPOSAL

A. Title: Growth and Mortality of Ozark Bass (*Ambloplites constellatus*) in Upper White River Basin Streams Compared to Other *Ambloplites* Species

B. Submitted By: Name
Mailing address
Phone number
Email address

C. Sponsor: Individual's name
Company/Organization
Address
Phone number

D. Date of Submission to Committee: June 20, 2013

E. Dates of Internship: May 31 through August 15, 2013

F. Credit Hours Requested: 3 hours

G. Brief Description of Proposed Activities: During my internship, I will learn techniques in fish sampling, fish aging, and data collection. Fish sampling techniques will include electrofishing and gill and hoop netting, among others. I will assist with stream habitat and restoration projects through the Cold Water Habitat and Stream Team programs. My specific research project will be comprised of estimating size and age distribution of Ozark Bass (a relative of Rock Bass endemic to the Upper White River Basin) on Crooked Creek, the Buffalo River, and other small streams and recording the measured information to compare to previous data from other similar species. This will be beneficial in the future to determine catch limitations and gage Ozark Bass's viability in the White River Basin. I'll also be measuring prominent water quality indicators.

H. LITERATURE REVIEW:

In the past, Ozark Bass, Rock Bass, and Shadow Bass were classified as a single specie, *A. rupestris*. In 1977, *A. rupestris* was split into 3 different species, and the Ozark Bass was renamed *Ambloplites constellatus* (Cashner and Suttkus, 1977). Minimal data has been published on growth or other population characteristics due to the recent split and the limited range of the Ozark Bass. Whisenant and Maughan, (1989) provided some of the only data available for the Ozark Bass including size at age. One of the project's objectives was to collect baseline data for the Ozark Bass to see if increased use had impacted the sport fisheries of the Buffalo River. The Arkansas Game and Fish Commission has electrofishing data including catch per unit effort and length frequency on Ozark Bass dating back to 1992, but no age data was collected (Todd, personal communication).

According to Buchanan and Robison (1988), the Ozark Bass is endemic to the Upper White River Basin. The Upper White River Basin is located in southern Missouri, north central and northwestern Arkansas over karst topography (Upper White River Basin Foundation, 2012). Ozark Bass generally inhabit stream pools that have high dissolved oxygen, continuous flow and low turbidity (Buchanan and Robison, 1988). The current average precipitation for Arkansas is 126.6 centimeters, and the average annual air temperature is 16.6° C with the summer temperatures as follows: June- 25.8° C, July- 27.7° C, August- 27° C (United States Geological Survey, 2005; Climate Zone, 2003).

Partly because of the porous karst, pressure from urbanization has become a recent concern (Upper White River Basin Foundation, 2012). Climate change models for the southeastern United States predict an increase in number and duration of droughts, higher average annual temperature, as well as heavy rain events (Environmental Protection Agency, 2013); therefore the Ozark Bass' habitat may be adversely affected. Since the Ozark Bass has a limited range, monitoring current population characteristics of the Ozark Bass would be beneficial in evaluations of future potential impacts on the population. More short term, population data aids fisheries biologists in evaluating current regulations to ensure that overfishing does not occur.

I. JUSTIFICATION:

The Ozark Bass (*Ambloplites constellatus*) is endemic to the Upper White River Basin, and a limited amount of data has been collected on the Ozark Bass population (Buchanan and Robinson, 1988). Data collected will be part of a long-term study of Ozark Bass by the Arkansas Game and Fish Commission to gather baseline data and to determine effectiveness of current harvest regulations in the Upper White River Basin. Baseline data are needed as reference for future expected changes in local fish populations in response to climate change or other impacts to the watershed.

Determination of length at age is required for calculation of growth and survival rates which determine population characteristics of Ozark Bass (Ricker, 1975). Length at age is an estimate of average size of fish at annual increments. Growth of Ozark Bass will be compared to existing data for Shadow Bass (*Ambloplites ariommus*) and Rock Bass (*Ambloplites rupestris*). Collecting age distribution data is important to determine mortality rates. Growth and mortality rates are useful for comparing different fish populations and evaluating harvest regulations (Ricker, 1975).

Conductivity, pH, water temperature, and dissolved oxygen will be measured before each collection as ancillary data. If differing growth or mortality rates occur between samples, measured water quality indicators may disclose reasons for conflicting data. Conductivity correlates with total dissolved solids and nutrient availability (Stan Todd, District 2 Fisheries Management Biologist, personal communication). Nutrient availability is a determining factor in fish growth (Todd, personal communication). Temperature also impacts growth rates due to the direct relationship between temperature and chemical reaction rates (Todd, personal communication). Extreme levels of dissolved oxygen and high or low pH can cause stress to the fish, causing more energy expenditure and less energy available for growth (Todd, personal communication). The sagittal otoliths will be used to determine age of Ozark Bass collected due to ease of readability and accuracy when compared to other aging methods (Maceina et al., 2007). Otoliths increase in size with fish size and leave dense rings during periods of slow growth. There is typically a primary annular ring that can be used to determine age in fish (Jearld, 1985).

J. OBJECTIVES:

The objective of this study is to collect and analyze population length frequencies and size at age data for Ozark Bass found in the Upper White River Basin to establish growth and mortality rates. Growth and mortality rates will be compared among sample locations and different *Ambloplites spp*. The hypotheses are that growth and mortality rates will be equal among streams and species.

K. METHODS AND MATERIALS:

Ozark Bass will be collected by boat electrofishing in the Upper White River Basin, including the Buffalo River and Crooked Creek, and potentially others. During the electrofishing process, direct current (DC) electricity is directed through the water via cathodes and anodes (Kolz et al., 2000). The cathode can either be a metal boat hull or separate electrodes used near the boat when using a fiberglass hull (Kolz et al., 2000). With DC electrofishing, the cathodes repel the fish, and the anodes attract the fish causing electro-narcosis when the fish approaches the anode (Kolz et al., 2000). While fish are anesthetized, nets will be used to collect Ozark Bass. See Figure 1 for a visual reference.

Collections will take place during the summer when water levels permit. Water levels must be less than 1.524 meters (5 feet) stage at Highway 65 in the Lower Wilderness Area of the Buffalo River and less than 3.048 meters (10 feet) stage at Kelly's Crossing on Crooked Creek for sampling to occur. Summer was chosen for the study because water levels are lower and fish are more concentrated, more active and easily caught during the warmer months of the year.

Ozark Bass sampling will be conducted in pools and other deep habitat reachable by boat. Each run (i.e., the length of actual shocking time between measuring fish) will be conducted for approximately ten minutes or the entire pool, if less time is required. Weights to the nearest 2 grams and lengths to the nearest millimeter will be recorded in the field. Ten fish per each centimeter size group will be saved for otolith retrieval. If the maximum of ten fish in any given size group is collected, extra fish collected in the same size group thereafter will be weighed, measured, and released. Growth of Ozark Bass can be affected by water quality; thus, pH, conductivity, water temperature, and dissolved oxygen will be measured and recorded in the field (see Figure 2). This data will be reserved in the instance that there are dramatic conflicts in data from stream to stream.

Sagital otoliths, two disc shaped bones found in the heads of boney fish that are used to estimate age, will be collected from the brain cavities of the Ozark Bass (see Figure 3) (University of Alaska-Fairbanks). Although the goal for collecting otoliths will be up to ten fish per each centimeter size group, in some instances, ten fish may not be possible in each size group due to availability. Otoliths will be taken back to the Arkansas Game and Fish laboratory for aging. Age data will be determined by using microscopes to observe the number of annuli found on the otoliths. Age will be recorded. Population age distribution will be estimated based on population length frequency and an age-key, generated from length and age of known aged fish (i.e. the otolith readings) (Quist et al., 2012). Growth and mortality will be estimated from population age distribution (Ricker, 1975). Growth and mortality rates will be statistically compared with similar data from different locations and with other species of the same genus.

L. REFERENCES:

Buchanan, T., and Robison, H. 1988. *Fishes of Arkansas*. The University of Arkansas Press, Fayetteville, Arkansas, p. 360-364.

Cashner, R.C., and Suttkus, R.D. 1977. *Ambloplites constellatus*, a new species of rock bass from the Ozark upland of Arkansas and Missouri with a review of western rock bass populations. *American Midland Naturalist*, v. 98, p.147-161.

Climate Zone. 2003. Little Rock[Online]. Available at http://www.climate-zone.com/climate/united-states/arkansas/little-rock/ (verified June 18, 2013).

Environmental Protection Agency. 2013. Climate Impacts in the Southeast[Online]. Available at http://www.epa.gov/climatechange/impacts-adaptation/southeast.html#impacts (verified June 6, 2013).

Jearld, A. 1985. Age Determination. Nielsen, L. and Johnson, D., eds., *In Fisheries Techniques*. Southern Printing Company, Inc., Blacksburg, Virginia, p. 301-324.

Kolz, A.L., Reynolds, J., Temple, A., Boardman, J., and Lam, D. 2000. *Principles and Techniques of Electrofishing*. U.S. Fish and Wildlife Service, Shepherdstown, West Virginia, p. 3-1, 10-1, 10-2, 10-3, 11-2.

Maceina, M.J., Boxrucker, J., Buckmeier, L.D., Gangl, R.S., Lucchesi, D.O., Isermann, D.A., Jackson, J.R., and Martinez, P.J. 2007. Current Status and Review of Freshwater Fish Aging Procedures Used by State and Provincial Fisheries Agencies with Recommendations for Future Direction. *Fisheries*, v. 32, p. 329-340.

Maughan, O.E., and Whisenant, K.A. 1989. Smallmouth Bass and Ozark Bass in Buffalo National River. Western Region National Park Service Department of the Interior, San Francisco, California, p. 1-58.

Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bulletin of Fisheries Research Board of Canada, Ottawa, Canada, p. 29-74.

Quist, M.C., Pegg, M.A., and DeVries, D.R. 2012. Age and Growth. Zale, A.V., Parrish, D.L., and Sutton, T.M., eds., *Fisheries Techniques,* 3rd ed. American Fisheries Society, Bethesda, Maryland. p. 677-721.

United States Geological Survey. 2005. Arkansas [Online]. Available at http://www.nationalatlas.gov/printable/images/pdf/precip/pageprecip_ar3.pdf (verified June 18, 2013).

University of Alaska-Fairbanks. What Is An Otolith?[Online]. Available at http://elearning.uaf.edu/cc/otolith/whatis.htm (verified June 18, 2013).

Upper White River Basin Foundation. 2012. The Upper White River: An Overview [Online]. Available at http://www.whiteriverbasin.org/basinoverview.php (verified June 18, 2013).

Figure 1. Collecting Ozark Bass via electrofishing at nighttime.

Figure 2. Gathering water quality data at the Buffalo River Lower Wilderness Area.

Figure 3. Collecting otoliths from the brain cavity of an Ozark Bass.

INTERNSHIP FINAL WRITTEN REPORT AND PRESENTATION

Guidelines

The final report should contain much of the same information from the proposal and with the same basic format/structure. The main title of the document should be "INTERNSHIP FINAL REPORT". A secondary sub-title matching your internship title should follow the main title. All of the information from sections 1, 2, and 3 of the proposal should be incorporated in the final report document. However, there may be revisions to this information that may need to be made based on what was actually done or what happened during the internship as it developed.

Section 4 should be titled "Results and Discussion", or something else appropriate if a mini-research project was not conducted for the internship. It is suggested that this section be divided up objective by objective as specified in the proposal (i.e., each objective listed as a sub-section heading). Under each objective, a description of what was done to accomplish the objective, what was learned, and how this information or skill will assist in reaching future goals should be provided. These descriptions should be specific and include details, which may necessitate taking notes throughout the internship or keeping a journal of daily/weekly activities. Graphs or tables of data collected, pictures, or other relevant images/figures are encouraged to include. If included, images/figures should be numbered consecutively as they are referenced in the text and be accompanied by at least a brief caption describing what is contained on the image/figure.

Section 5 should be a complete list of references cited in your final report document.

The final report should be turned into the committee within four (4) weeks after the specified ending date of the internship.

The presentation should be prepared in PowerPoint and highlight the activities of your internship, including some background information, a justification for your internship (i.e., why you did one), and a description of your methods, results, and conclusions (i.e., what did you learn and/or how will the internship help you in the future). Figures of summarized data may be necessary to prepare, include, and discuss. Pictures of what you did and where you did it would be appropriate to include as well.

The presentation will need to be scheduled in a timely manner, but no earlier than one (1) week after submitting the final report to the committee for their review.

EXAMPLE FINAL REPORT

INTERNSHIP FINAL REPORT

A. **Title:** Growth and Mortality of Ozark Bass *Ambloplites constellatus* in Upper White River Basin Streams Compared to Other *Ambloplites* Species and Between Crooked Creek and the Lower Wilderness Area of the Buffalo River

B. **Submitted By:** Name
Mailing address
Phone number
Email address

C. **Sponsors:** Individual's name
Company/Organization
Address
Phone number

D. **Date of Submission to Committee:** August 15, 2013

E. **Dates of Internship:** May 31 through August 8, 2013

F. **Credit Hours Requested:** 3 hours

G. **Brief Description of Activities:** During my internship, I learned techniques in fish sampling, fish aging, and data collection. Fish sampling techniques included boat electrofishing and backpack shocking. I assisted with stream habitat and restoration projects through the Cold Water Habitat and Stream Team programs. My specific research project was comprised of estimating size and age distribution of Ozark bass (a relative of Rock bass endemic to the Upper White River Basin) on Crooked Creek and the Buffalo River. The data was used to determine growth and mortality rates and was compared to previous data from other similar species and between water bodies. This will aid Arkansas Game and Fish Commission biologists in the future to determine catch limitations and gage Ozark bass' viability in the White River Basin. I also measured prominent water quality indicators.

H. LITERATURE REVIEW:

In the past, Ozark bass, Rock bass, and Shadow bass were classified as a single species, *Ambloplites rupestris*. In 1977, *A. rupestris* was split into 3 different species, and the Ozark bass was renamed *Ambloplites constellatus* (Cashner and Suttkus, 1977). Minimal published data is available on growth or other population characteristics due to the split and the limited range of the Ozark bass. Whisenant and Maughan (1989) provided some of the only data available for the Ozark bass, including mean size at age (Table 1). One of their objectives was to collect baseline data for the Ozark bass to see if increased recreational pressures and angling effort had impacted the sport fisheries of the Buffalo River. AGFC has collected electrofishing data on Ozark bass since 1992; however, no age data was collected (Todd, personal communication).

According to Buchanan and Robison (1988), the Ozark bass is endemic to the Upper White River Basin. The Upper White River Basin is located in southern Missouri, north central and northwestern Arkansas over karst topography (Upper White River Basin Foundation, 2012). Ozark bass generally inhabit stream pools that have high dissolved oxygen, continuous flow and low turbidity (Buchanan and Robison, 1988). The current mean precipitation for Arkansas is 126.6 centimeters, and the mean annual air temperature is 16.6° C with the summer temperatures as follows: June- 25.8° C, July- 27.7° C, August- 27° C (United States Geological Survey, 2005;Climate Zone, 2003).

The White River Basin Foundation (2012) points out several concerns in the White River watershed including the ease of groundwater contamination in the karst geology of the area, increased urbanization and alteration of watershed hydrology, and increasing confined animal feeding operations. Climate change models for the southeastern United States predict an increase in number and duration of droughts, higher mean annual temperature, as well as heavy rain events with shorter duration (Environmental Protection Agency, 2013). Changes in watershed hydrology, whether from increased urbanization or climate change could potentially alter stream morphology, and therefore impact the Ozark bass' habitat. Population data aids fisheries biologists in evaluating current regulations to ensure that overfishing does not occur. Recent limitations on harvest pertaining to other sport fishes in Buffalo River and Crooked Creek may have increased harvest of the Ozark bass in those streams. Currently, there is a creel limit of ten fish and no size limit for Ozark bass, Rock bass, and Shadow bass combined (Arkansas Game and Fish Commission, 2013). Since the Ozark bass has a limited range, monitoring current population characteristics of the Ozark bass is beneficial in evaluation of current and future potential impacts on the population.

I. JUSTIFICATION:

The Ozark bass *Ambloplites constellatus* is endemic to the Upper White River Basin, and a limited amount of data has been collected on the Ozark bass population (Buchanan and Robinson, 1988). Data collected during this study is part of a long-term attempt by the Arkansas Game and Fish Commission (AGFC) to gather baseline data on the Ozark bass population and to determine the efficacy of current harvest regulations for that species in the Upper White River Basin. Baseline data will be used in the future to determine whether the local fish populations change in response to climate change or other impacts to the watershed.

Growth rates and mortality rates, important metrics of any fish population, are useful for comparing different fish populations and evaluating harvest regulations (Ricker, 1975). Age distribution data is collected to aid in the determination of length at age, which is required for the calculation of growth rates and mortality rates (Ricker, 1975). Length at age is an estimate of mean size of fish at annual increments. The sagittal otoliths were used to determine the age of Ozark bass collected due to ease of readability and accuracy when compared to other aging methods (Maceina et al., 2007). Otiliths increase in size with fish size and leave dense rings during periods of slow growth. These annular rings can be used to determine age in fish (Jearld, 1985). In this study, growth of Ozark bass were compared to existing data for Shadow bass *A. ariommus* and Rock bass *A. rupestris,* and mortality rates were compared between sampled sites.

Conductivity, pH, water temperature, and dissolved oxygen were measured before each collection as ancillary data. If differing growth or mortality rates occurred between samples, measured water quality indicators could potentially disclose reasons for conflicting data. Conductivity correlates with total dissolved solids and nutrient availability (Stan Todd, District 2 Fisheries Management Biologist, personal communication). Nutrient availability is a determining factor in fish growth (Todd, personal communication). Temperature also impacts growth rates due to the direct relationship between temperature and chemical reaction rates (Todd, personal communication). Extreme levels of dissolved oxygen and high or low pH can cause stress to the fish, causing more energy expenditure and less energy available for growth (Todd, personal communication).

J. OBJECTIVES:

The objective of this study was to collect and analyze population length frequencies and size at age data for Ozark bass found in the Upper White River Basin to determine growth and mortality rates. Growth rates were compared to different *Ambloplites spp*., and mortality rates were compared among sample locations. The hypotheses were that growth rates would be similar among species and mortality rates would be equal among streams.

K. METHODS AND MATERIALS:

Ozark bass were collected by boat electrofishing in the Upper White River Basin, including the Lower Wilderness Area of the Buffalo River and Crooked Creek (see Figure 1). During the electrofishing process, pulsed direct current (DC) electricity was directed through the water via cathodes and anodes (Kolz et al., 2000). The cathode can either be a metal boat hull or separate electrodes used near the boat when using a fiberglass hull (Kolz et al., 2000). With DC electrofishing, the cathodes repel the fish, and the anodes attract the fish causing electro-narcosis when the fish approaches (Kolz et al., 2000). While fish were anesthetized, nets were used to collect Ozark bass (Figure 2).

Collections took place during the summer when water levels permitted. The Buffalo River was sampled June 10th, 11th, and 12th, and Crooked Creek was sampled June 21st and 24th. Water levels had to be less than 1.524 meters (5 feet) stage at Highway 65 in the Lower Wilderness Area of the Buffalo River and less than 3.048 meters (10 feet) stage at Kelly's Crossing on Crooked Creek for sampling to occur. Summer was chosen for the study because water levels are lower and fish are more concentrated, more active and easily caught during the warmer months of the year.

Ozark bass sampling was conducted in pools and other deep habitat reachable by boat. Each run (i.e., the length of actual shocking time between measuring fish) was conducted for approximately ten minutes. Weights to the nearest ±2 grams and total lengths to the nearest millimeter were recorded in the field. Ten fish per each centimeter size group were saved for otolith retrieval, if available. If the maximum of ten fish in any given size group were collected, extra fish collected in the same size group thereafter were weighed, measured, and released. Growth of fish can be affected by water quality; thus, pH, conductivity, water temperature, and dissolved oxygen were measured and recorded in the field (see Figure 3). This data was reserved in the instance that there were dramatic conflicts in data from stream to stream.

Sagittal otoliths, two disc shaped bones found in the heads of boney fish that are used to estimate age, were collected from the brain cavities of the Ozark bass (see Figure 4) (University of Alaska-Fairbanks). Although the goal for collecting otoliths was up to ten fish per each centimeter size group, in some instances, ten fish were not possible in each size group due to a lack of availability. Otoliths were taken back to the AGFC laboratory for aging. Otoliths were glued to glass slides and, if needed, sectioned with a Buehler Isomet low-speed saw. Age data was determined by using microscopes to observe the number of annuli found on the otoliths. Age was recorded. Population age distribution was estimated based on population length frequency and an age-length key, generated from lengths and ages of known aged fish (i.e. the otolith readings) (Quist et al., 2012). Growth and mortality rates were estimated from population age distribution (Ricker, 1975). Mortality rates were statistically compared with similar data from different locations; growth rates were compared among species.

L. RESULTS AND DISCUSSION

One hundred and thirty-nine Ozark bass were sampled in the Buffalo River Lower Wilderness Area, 57 were collected near Middle Creek, 45 above Leatherwood Creek, and 37 below Leatherwood Creek. Six runs occurred near Middle Creek, five above Leatherwood Creek, and five below Leatherwood Creek (Figures 5 to 7). Total time electrofishing was 257 minutes.

A total of 188 Ozark bass were sampled in Crooked Creek, 86 fish were collected at the Education Center site (61 minutes of sampling) and 102 at the Pyatt site (47 minutes of sampling). Five runs occurred at both the Education Center location and at the Pyatt site (Figures 8 and 9).

Length and catch per unit effort (CPUE, fish per hour) data from the Ozark bass samples from the Lower Wilderness Area on the Buffalo River and Crooked Creek were compiled into a length frequency graph using Microsoft Excel (Figure 10).

Mean CPUE of Ozark bass in the Buffalo River was 31.2 fish per hour, with the 95% confidence interval of 26.3 fish per hour to 36.25 fish per hour. The shortest fish sampled from the Buffalo River was 61 mm, and the longest fish was 256 mm. There is a noticeable decline in number of fish from the Buffalo River caught per hour over 22 cm, with no fish collected in the 24 centimeter class.

The mean CPUE of Ozark bass in Crooked Creek was 101.5 fish per hour. The 95% confidence interval for the population's mean was 71.9 fish per hour to 131.1 fish per hour. Sizes of fish sampled from Crooked Creek ranged from a minimum of 88 mm to a maximum of 260 mm. There was a decrease in the number of fish caught per hour above 21 cm.

Figure 10 clearly depicts that there was a greater number of fish caught per hour from Crooked Creek than the Buffalo River. Since CPUE is directly related to density, there was a greater density of fish in Crooked Creek.

A different way to represent size distribution of the Ozark bass that were collected is through relative stock density (RSD). RSD, shown in Figure 11 and Tables 2 and 3, groups fish into various size classes that are determined based on the size of the current world record fish. Since there is minimal data for Ozark bass, so RSD size class data for Rock bass were used. Sizes include Stock, Quality, Preferred, Memorable, and Trophy. The corresponding length for these classes are ≥100 mm for Stock, ≥180 mm for Quality, ≥230 mm for Preferred, ≥280 mm for Memorable, and ≥330 mm for Trophy. Fish under Stock size (<100 mm) were not included in the Figure 11 because those fish were not significant when considering the impacts of angling pressure on the Ozark bass population. Relative abundance, in percentages, of each size class and the 95% confidence intervals for the relative abundance percentages are shown in Table 2 for the Buffalo River and Table 3 for Crooked Creek.

Mean length of Ozark bass greater than stock size sampled from the Lower Wilderness Area of the Buffalo River was 164 mm with a 95% confidence interval of 156 mm to 171 mm. The minimum length of fish greater than Stock size was 107 mm, and the maximum length over Stock size sampled was 256 mm.

The mean size of Ozark bass sampled from Crooked Creek that were greater than Stock size was 164 mm with a 95% confidence interval of 158 mm to 169 mm. The smallest sized fish greater than Stock size was 103 mm, and the largest fish was 260 mm.

According to Figure 11 and Tables 2 and 3, the percentage of fish found in each size category decreases with increasing size category in the Buffalo River and Crooked Creek. The RSD graph depicts that there is a similar size distribution of fish between the Buffalo River and Crooked Creek.

Differential growth patterns between sexes have been observed in some fish, such as long-eared sunfish *Lepomis megalotis* found in the Buffalo River (Todd, personal communication); therefore, gender of each Ozark bass was recorded during the Buffalo River sampling so that comparisons of growth rates by sex could be made. Figure 12 depicts that both genders appeared to grow at a similar rate; thus, no further attempt was made to differentiate males from females.

Figure 13 graphically depicts a logarithmic relationship between weight and length data from the Buffalo River and Crooked Creek. A Student's t-test was performed to check for a significant difference between slopes of the log transformed lengths and weights data from the Buffalo River and Crooked Creek; slopes were not significantly different at an alpha (α) level of .05. Hence, all data were combined, and one length weight relationship graph was created to represent both sets of data. As the lengths of the Ozark bass increased the weights also increased. The equation $W = 1E^{-05}L^{3.0848}$ is a logarithmic regression created by Microsoft Excel to fit the sampled data set. R^2 represents how well the line describes the variability in the data. In this case 99% of the variability in weight of Ozark Bass was explained by length.

Relative weight (W_r) is a comparison between the weight of a sampled fish compared to a standard weight generated from a standard weight equation for that species. W_r gives an index of condition or plumpness for the sampled fish. The equation for W_r is:

$$W_{r=}\left(\frac{Weight\ of\ Fish}{\alpha * Length\ of\ Fish^{\beta}}\right) * 100$$ (Anderson and Gutreuter, 1983)

A Shadow bass standard weight equation was used due to the unavailability of standards for Ozark bass. The parameters used were α= -5.1461 and β=3.2110 (Mareska and Jackson, 2002). Shadow bass are a different species of fish, so Ozark bass may not have the exact same standards; however, Shadow bass data sufficed as a comparison tool between the two sampled areas.

The mean W_r of Ozark Bass in the Buffalo River was 85, with a variance of 36.05. Crooked Creek's relative weight was 92, and the creek had a variance of 50.45. Minimum relative weight for the Buffalo River was 70 and maximum relative weight was 100. Minimum relative weight for Crooked Creek was 72, while maximum relative weight was 114.

Based on the W_r results, Ozark bass in Crooked Creek appeared to be in slightly better condition than those in the Buffalo River. This would suggest that food availability was greater in Crooked Creek than in Buffalo River. This may partially explain the higher density of Ozark Bass in Crooked Creek.

Otoliths were retrieved and aged from 117 Ozark bass during the Buffalo River sampling and 127 Ozark bass from the Crooked Creek sampling. From the age data collected, an age-length key was derived, which allowed us to calculate the age of sampled fish that were not kept for otolith retrieval. Then, the lengths of fish in each individual age group were averaged together. Table 4 and Table 5 show the mean length, variance, and number of fish in each age category from both streams. Table 1 shows the mean length at age data and number of fish collected from the Buffalo River by Whisenant and Maughan (1989) in 1980 and 1981. When comparing the two sets of data, Whisenant and Maughan's length data appears to be classified under the wrong age classes. For example, if all of Whisenant and Maughan's length data were shifted to one age class older, then both data sets would show similar growth among Ozark bass. Scales were used to determine age of Ozark bass collected by Whisenant and Maughan, and this might be the reason for inaccurate age classification. The number of fish that Whisenant and Maughan were able to obtain while sampling was drastically greater than the Ozark bass collected in this study. This led us to believe there are less Ozark bass available for sampling in the Buffalo River now than when Whisenant and Maughan did their collections. The National Park Service has unpublished data records of the number of visitors to the Buffalo National River since 1973 (Figure 14) (Hodges, 2013). The number of visitors to the Buffalo River has doubled since Whisenant and Maughan collected length at age data on Ozark bass; inferring that increased visitation to the Buffalo River has led to a decrease in the number of Ozark bass in the river.

Figure 15 shows the length at age for both sampled water bodies. Von Bertalanffy equations were fitted to the graph to represent growth curves for the sampled areas. The von Bertalanffy equation is as follows: $L_t=L_\infty[1-e^{-k(t-t_o)}]$, with L_t equaling the length at a certain age, L_∞ equaling the longest length that fish in the population will ever grow, k equaling a growth constant, t_o equaling the hypothetical age of the fish at length zero, and t equaling the age of the fish (Pine et al., 2012). The terms in our equation for the Buffalo River area equaled 258 mm for maximum length attainable (L_∞), 0.346 for the growth constant (k), and -0.087 for length at zero age (t_o). The terms in our equation for the Crooked Creek sample equaled 260 mm for maximum length attainable (L_∞), 0.299 for growth rate (k), and -0.328 for length at zero age (t_o).

Figure 15 portrays that as the age of Ozark bass increased, the growth rates slowed and became more similar at both sample sites; therefore, growth rates between Crooked Creek sample sites and Buffalo River sample sites were comparable.

Growth data for Rock bass collected from Osage Fork by the Missouri Department of Conservation and for Shadow bass collected from the Spring River by the AGFC were compiled into Figure 15 to compare growth between species (Johnson et al., 2011; Pratt, 2013). Shadow bass were depicted as initially growing faster; however this might have been due to errors in measurement of small fish or time of year fish were collected. As age increased, the growth rate of Shadow bass became analogous to that of Ozark bass. Rock bass, however, grew faster and larger than both Ozark bass and Shadow bass.

Lengths at age were estimated using the von Bertalanffy equation, and growth rates were then calculated from those estimates. The growth models for the Buffalo River and Crooked Creek indicated that growth rates for Ozark bass were similar between water bodies; however, results in Tables 6 and 7 show that the Ozark bass in the Buffalo River initially grew faster than the Crooked Creek fish. Growth rates slowed in both water bodies at approximately age five, and the growth rate of Crooked Creek fish slightly surpassed that of the Buffalo River fish after age five. Size selective mortality (angling) might have been a factor in the slower growth rate estimates of the older fish in the Buffalo River, as anglers tend to keep the faster growing, better conditioned fish, leaving only the slower growing fish in the larger sizes. Growth rates between the Pyatt sampling site and Education Center site were also compared, and like the growth rates found on Crooked Creek and the Buffalo River, the two sample sites were similar.

Water quality indicators collected at locations on the Buffalo River and Crooked Creek were found to have similar values, as shown in Table 8.

Mortality rates for the Lower Wilderness Area of the Buffalo River and Crooked Creek were calculated using the Chapman-Robson method. Mortality rates were calculated for three different age categories: two to nine years old, two to five years old, and five to nine years old. The reason for breaking the population into different age groups is due to the Buffalo River's Length At Age graph indicating a deviation from the von Bertalanffy growth model after age-5 (Figure 16). Age-1 fish were not included in the calculations since fish younger than age-2 were not fully recruited to the sampling gear, and therefore their numbers were probably underestimated. Tables 9 and 10 show the mortality rate, variance, and number of fish sampled for each age category at both sampled areas.

The two sampling sites on Crooked Creek were further broken down to show individual site mortality rates because there were differences in size distribution at the two sampling sites. More and larger fish were collected at the Pyatt site, implying that there was a greater mortality rate at the Education Center site. We suspect that the Education Center site on Crooked Creek has greater angling pressure than the Pyatt site. Tables 11 and 12 show mortality rate, variance, and number of fish sampled in each age category for Pyatt and the Education Center.

A Student's t-test was performed to check for a significant difference between the mortality rates in each age category on the Buffalo River and Crooked Creek. Crooked Creek was further tested by statistical comparison between sample sites and the Buffalo River. The t-test showed a significant difference between mortality rates in all age categories on the

Buffalo River and Crooked Creek, between the Pyatt site and Education Center site, and the Buffalo River and Pyatt site. Comparison between the Buffalo River and Education Center site revealed no significant difference in the mortality rate of Ozark bass in the two to five age category. A significant difference was shown in the other age categories in the comparison between the Buffalo River and the Education Center site.

The results of the Student's t-test on mortality rates between the sampled areas discloses the following results: 1) Overall, the lowest mortality rate of Ozark bass found among the sampled areas was at the Pyatt sample site. 2) The Education Center site had the highest mortality rate, except when comparing the site's two to five age category to the Buffalo River. 3) The Buffalo River's mortality rate was between the Education Center and Pyatt sites' mortality rates, except in the two to five age category when compared to the Education Center site. 4) The mortality rates of the Buffalo River and the Education Center site in the two to five age category were not statistically different. 5) Mortality rates were significantly higher at all sites in the five and up age category when compared to the other age categories.

Total mortality is made up of fishing mortality (e.g. anglers harvesting fish and fish death due to hooking) and natural mortality (e.g. predators, disease, and water quality issues). A possible reason for low mortality at the Pyatt sample site is less total mortality than the other sampled areas which could be due to lower angling pressure. Higher mortality at the Education Center site might have been due to higher levels of fishing mortality (e.g. angling pressure) due to the ease of accessibility and popularity of the site by anglers. Increased mortality in the five and up age category at all sampled areas leads us to believe that anglers are harvesting larger, better conditioned fish. As Figure 14 depicts, there has been a two-fold increase in visitors to the Buffalo River since 1980, and number of Ozark bass has likely decreases since Whisenant and Maughan's study. Hence, angling pressure is likely responsibility for the high mortality of the age-5+ fish. Since little data has been collected to know for certain that anglers are the main cause for differing mortality between streams and high mortality in the five and up age category, creel surveys are planned for the Buffalo River and possibly Crooked Creek in the near future to assess angler impacts to the fisheries. The creel surveys will gather data about number of anglers utilizing the water bodies and other valuable data when considering angling pressures. This study has gathered preliminary data that will be used as baseline data and may possibly lead to future regulations pertaining to Ozark bass in the Upper White River Basin.

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Table 1. Mean calculated total length of Ozark bass of different ages, calculated from seasonal catch data in Buffalo River, Arkansas (Maughan and Whisenant, 1989).

Season	**Year**	**# Of Fish**	**Age-1**	**Age-2**	**Age-3**	**Age-4**	**Age-5**	**Age-6**	**Age-7**	**Age-8**
Summer	'80	1090	-----	90.4	117.1	148.6	178.6	209.7	228.2	256.4
Fall	'80	287	-----	107.2	128.9	157.4	182.7	209.8	243.6	-----
Winter	'80	340	59.4	94.7	138.4	171.5	194.7	211.4	-----	-----
Spring	'81	300	53.4	93.5	138.0	170.1	182.9	206.4	-----	-----
Summer	'81	788	51.4	91.7	135.9	172.2	197.7	224.0	231.0	-----

Table 2. RSD for Buffalo River.

Relative Stock Density- Buffalo River		
RSD Size Category	**Relative Abundance**	**95% Confidence Intervals**
Stock to Quality (100 mm to 179 mm)	60.5%	59.7% to 61.3%
Quality to Preferred (180 mm to 229 mm)	36.1%	35.3% to 36.9%
Preferred to Memorable (230 mm to 279 mm)	3.4%	3.1% to 3.7%
Stock size (<100 mm)	14.4%	13.9% to 14.9%
Memorable to Trophy (280 mm to 329 mm)	----------	----------
Trophy (≥330 mm)	----------	----------

Table 3. RSD for Crooked Creek.

Relative Stock Density- Crooked Creek		
RSD Size Category	**Relative Abundance**	**95% Confidence Intervals**
Stock to Quality (100 mm to 179 mm)	59.4%	58.9% to 60.0%
Quality to Preferred (180 mm to 229 mm)	36.7%	36.1% to 37.2%
Preferred to Memorable (230 mm to 279 mm)	3.9%	3.7% to 4.1%
Stock size (<100 mm)	4.3%	4.0% to 4.5%
Memorable to Trophy (280 mm to 329 mm)	----------	----------
Trophy (≥330 mm)	----------	----------

Table 4. Growth data for Buffalo River.

Buffalo River Length At Age									
Age	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mean Length	76.3	130	183	207	216	214	208	-----	258
Variance	109	189	117	117	81.3	433	-----	-----	-----
Number of Fish	21	46	20	9	16	3	1	0	1

Table 5. Growth data for Crooked Creek.

Crooked Creek Length At Age									
Age	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mean Length	83.6	128	173	195	205	206	230	238	253
Variance	14.8	156	81.9	76.7	60.3	124	113	32	40.5
Number of Fish	5	40	32	8	23	3	2	2	2

Table 6. 2012-13 growth rates in Crooked Creek sample sites combined.

CROOKED CREEK		
AGE	**LENGTH AT AGE (mm)**	**2012-13 GROWTH RATE (mm/year)**
1	86.2	44.1
2	130.3	32.9
3	163.2	24.6
4	187.8	18.3
5	206.1	13.7
6	219.8	10.2
7	230.0	7.6
8	237.6	5.7
9	243.3	-----

Table 7. 2012-13 growth rates in Buffalo River sample sites.

BUFFALO RIVER (LOWER WILDERNESS AREA)		
AGE	**LENGTH AT AGE (mm)**	**2012-13 GROWTH RATE (mm/year)**
1	80.8	51.8
2	132.6	36.7
3	169.3	25.9
4	195.2	18.4
5	213.6	13
6	226.6	9.2
7	235.8	6.5
8	242.3	4.6
9	246.9	------

Table 8. Water quality records for sample sites on Buffalo River and Crooked Creek.

Water Quality Indicators				
Location	***pH***	***Temperature (°C)***	***Conductivity (μS)***	***Dissolved Oxygen***
Middle Creek, Buffalo River	8.1	25.9	208	7.84
Leatherwood Shoals, Buffalo River	8.1	28.9	212	9
Elephant Head, Buffalo River	8.7	28.3	217	8.4
Education Center, Crooked Creek	8.4	27.5	332	8.5

Table 9. Mortality rates for the Lower Wilderness Area of the Buffalo River.

Lower Wilderness Area of Buffalo River Mortality Rates			
Age	**Mortality (%)**	**Variance**	**Number of fish**
2-9	49.3	.001	119
2-5	47.0	.003	111
5-9	65.0	.007	23

Table 10. Mortality rates for Crooked Creek sample sites combined.

Crooked Creek Mortality Rates			
Age	**Mortality (%)**	**Variance**	**Number of fish**
2-9	45.8	.001	184
2-5	41.0	.002	172
5-9	60.6	.003	43.4

Table 11. Mortality rates for Crooked Creek at Education Center sample site.

Education Center Sample Site of Crooked Creek Mortality Rates			
Age	**Mortality (%)**	**Variance**	**Number of fish**
2-9	51.7	.002	80
2-5	47.0	.004	78
5-9	77.1	.008	18

Table 12. Mortality rates for Crooked Creek at Pyatt sample site.

Pyatt Sample Site of Crooked Creek Mortality Rates			
Age	**Mortality (%)**	**Variance**	**Number of fish**
2-9	39.6	.001	79
2-5	23.0	.007	72
5-9	57.0	.008	19

Figure 1. Location of Crooked Creek and Buffalo River in Marion County, AR.


Figure 2. Collecting Ozark bass via electrofishing at nighttime.

Figure 3. Gathering water quality data at the Buffalo River Lower Wilderness Area.

Figure 4. Collecting otoliths from the brain cavity of an Ozark bass.

Figure 5. Buffalo River sample area #1.

Figure 6. Buffalo River sample area #2.

Figure 7. Buffalo River sample area #3.

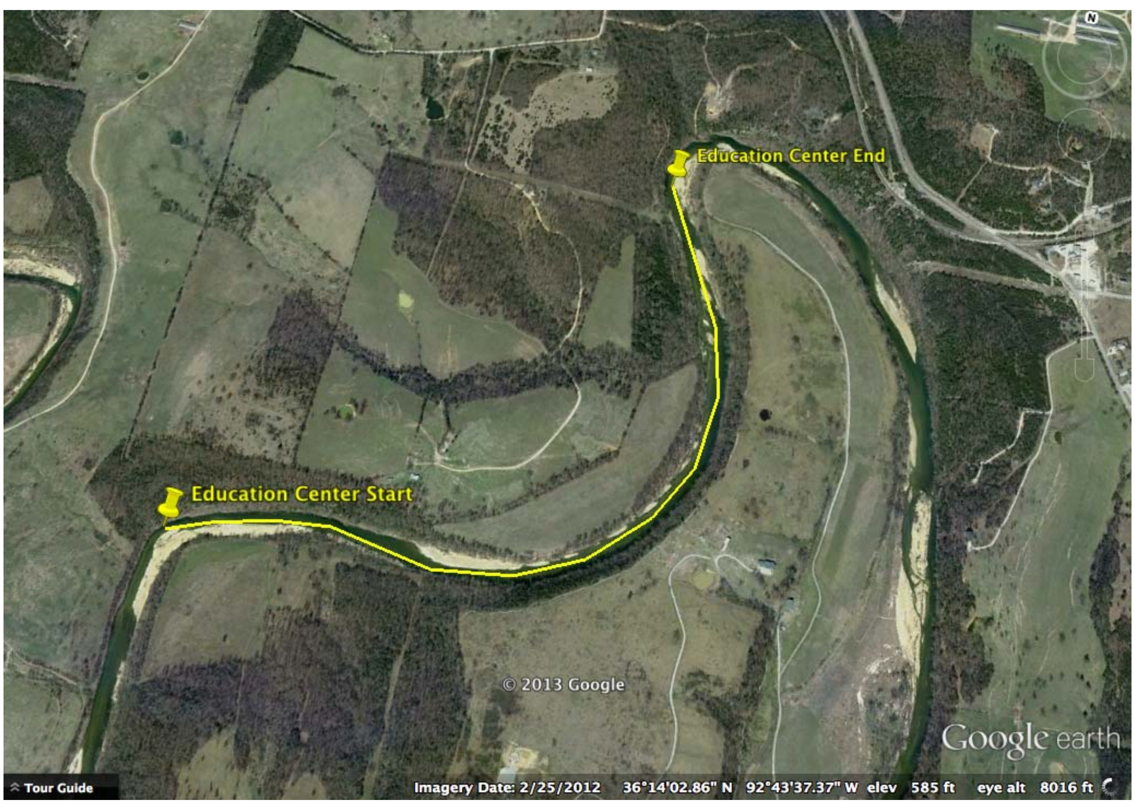

Figure 8. Crooked Creek Education Center sample area.

Figure 9. Crooked Creek Pyatt sample area.

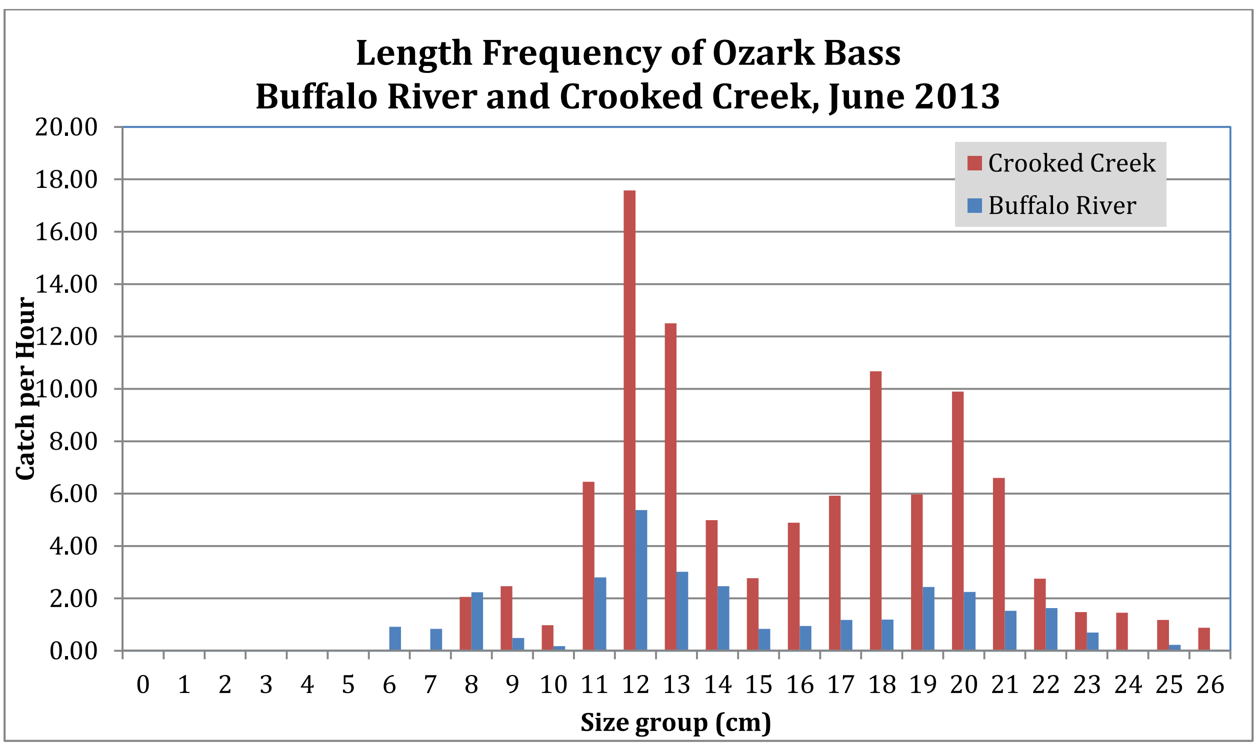

Figure 10. Catch-per-unit-effort (CPUE, catch per hour) per size group for the Lower Wilderness Area of the Buffalo River and Crooked Creek.

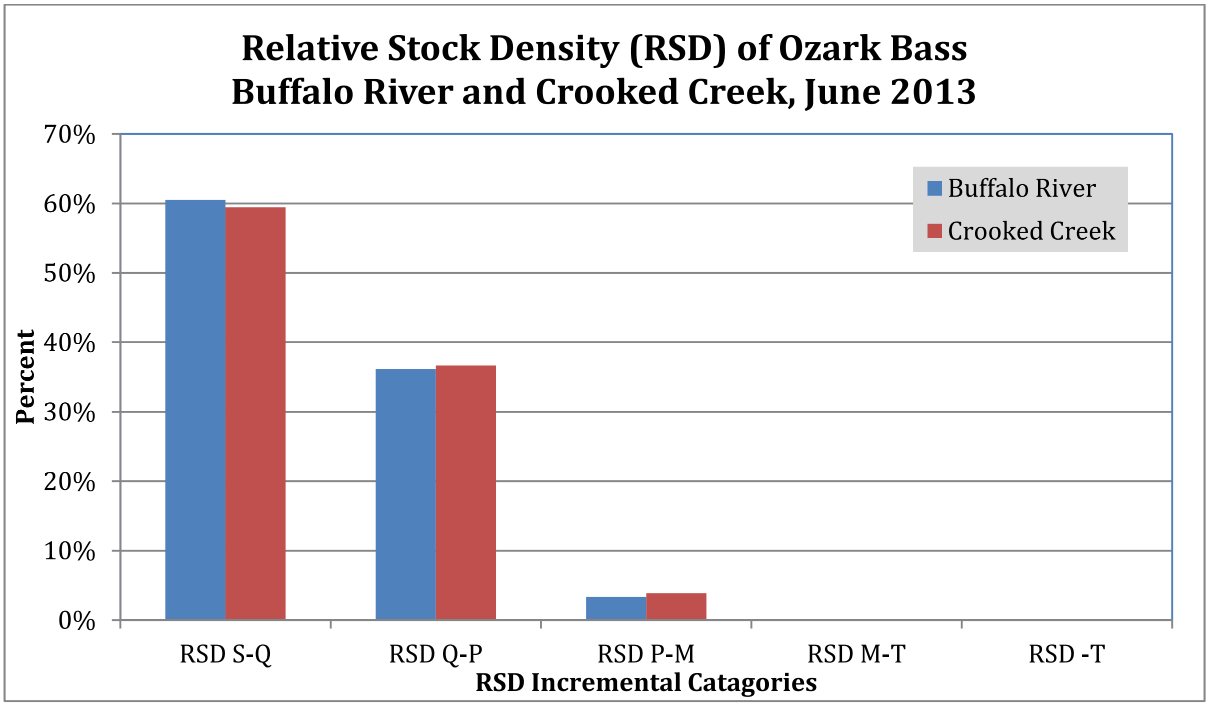

Figure 11. Relative stock density for the Lower Wilderness Area of the Buffalo River and Crooked Creek.

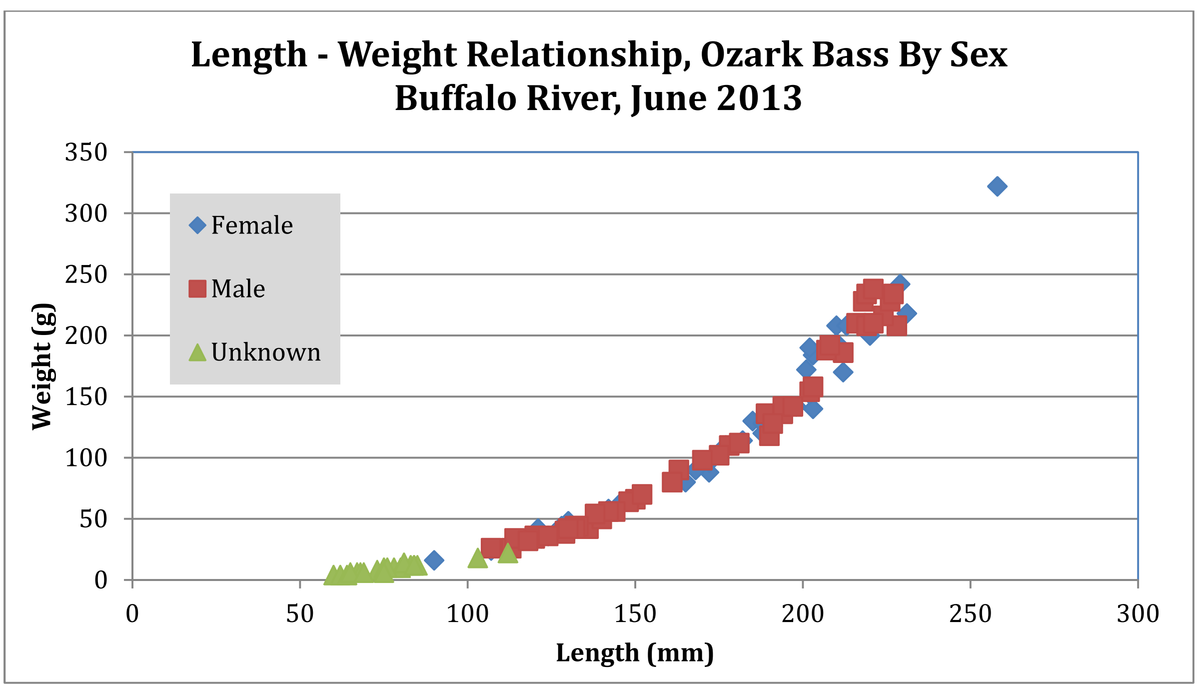

Figure 12. Length-weight relationship by sex for the Lower Wilderness Area of the Buffalo River.

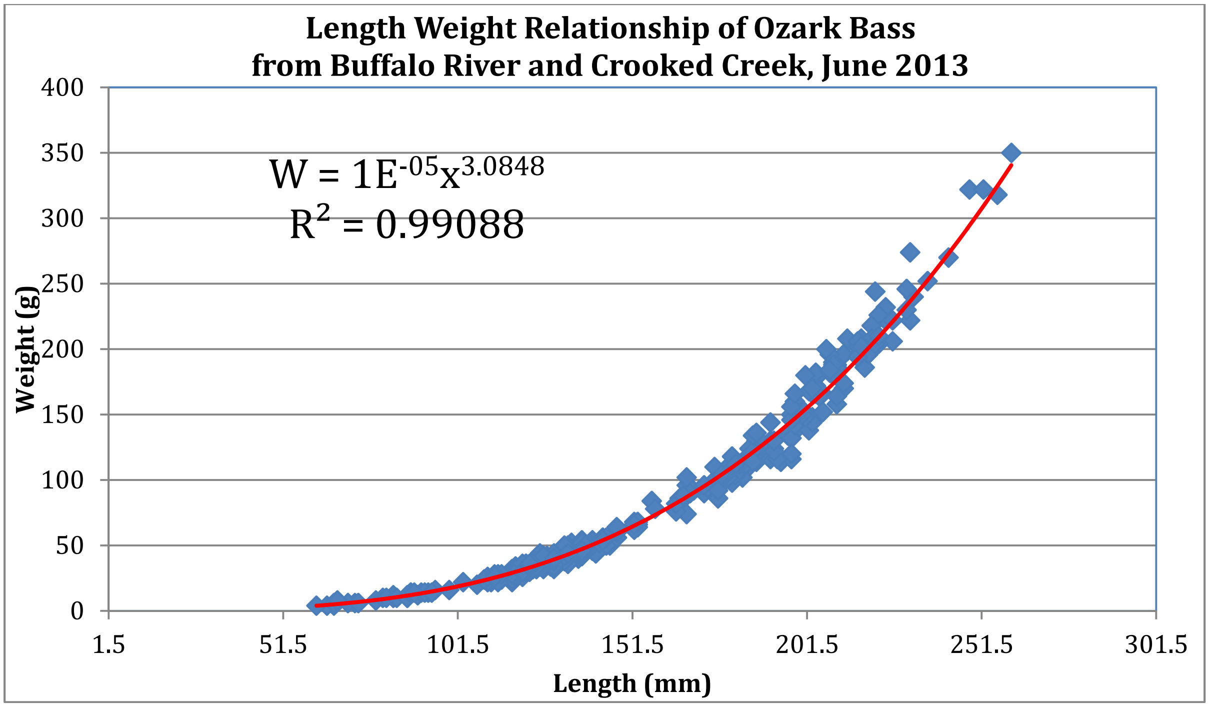

Figure 13. Length-weight relationship for the Lower Wilderness Area of the Buffalo River and Crooked Creek.

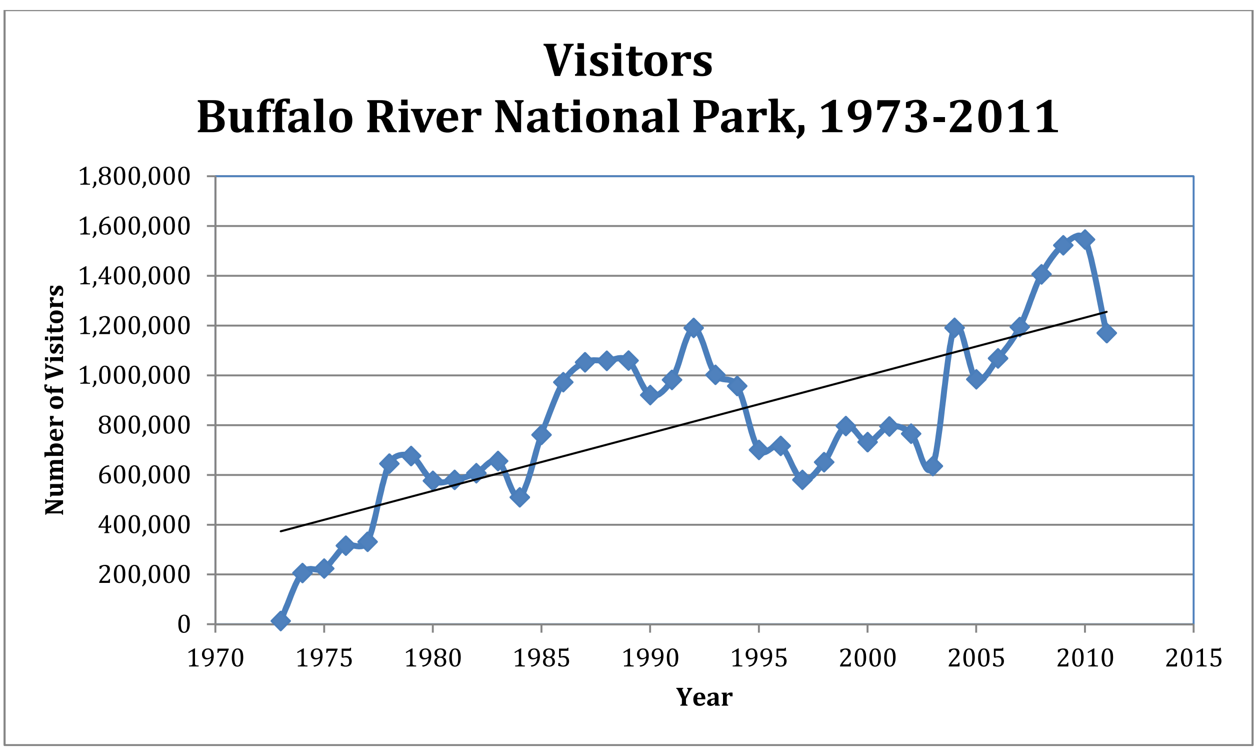

Figure 14. National Park Service visitor data (Hodges, 2013).

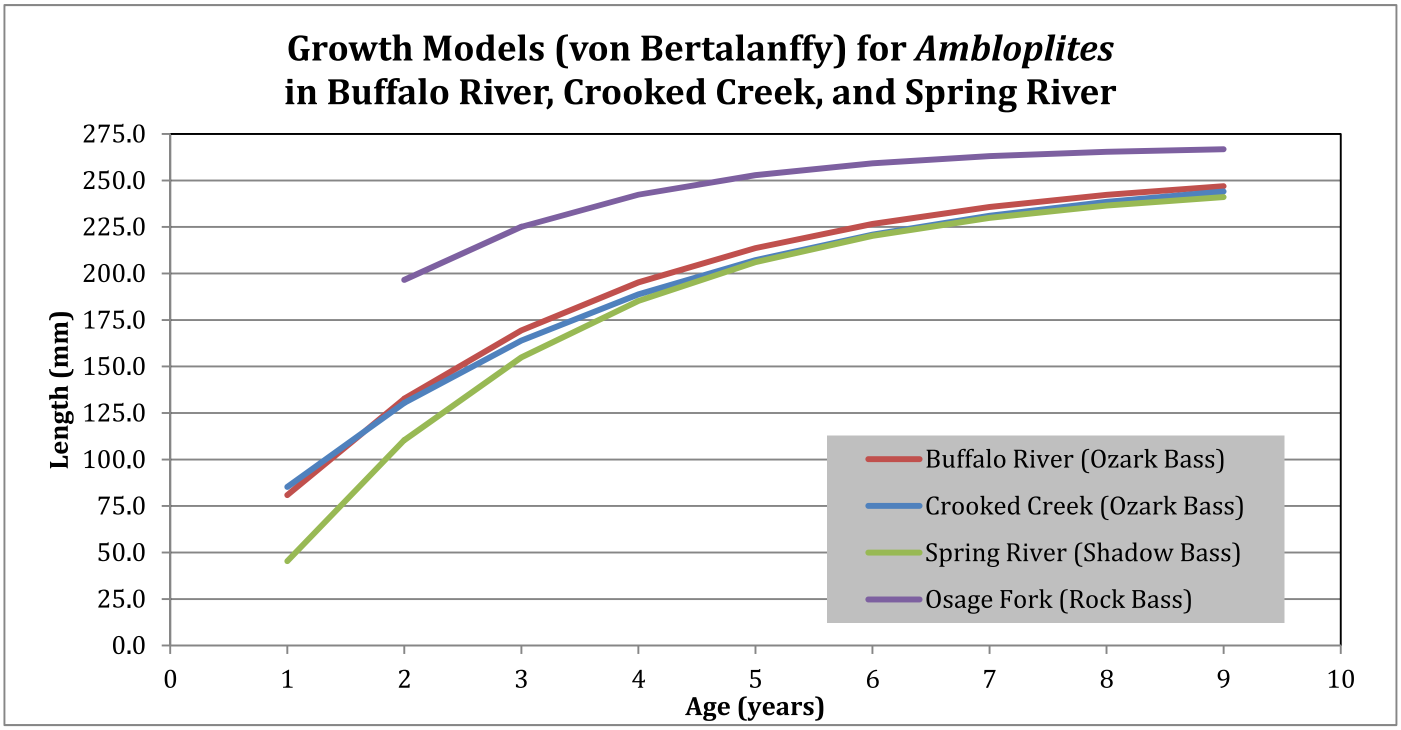

Figure 15. von Bertalanffy growth curves for Ozark bass, Shadow bass, and Rock bass.

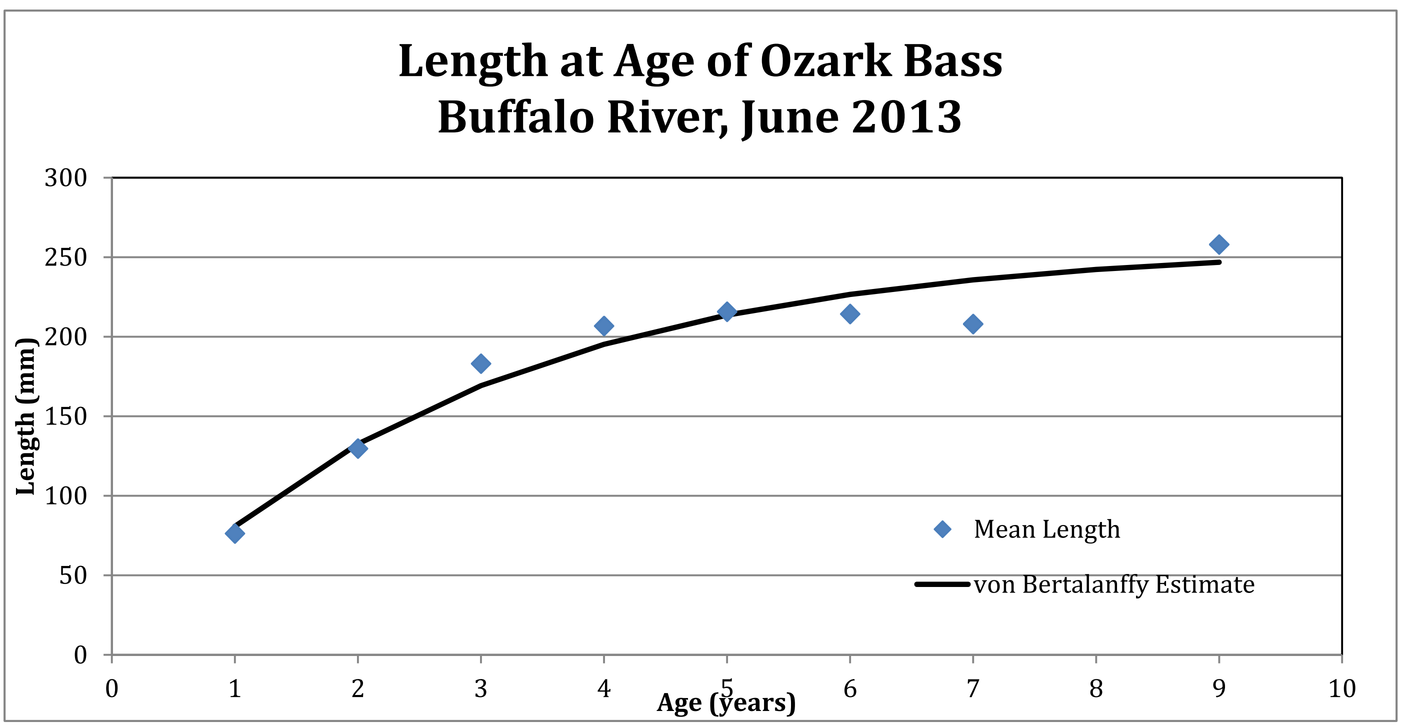

Figure 16. von Bertalanffy growth curve for Buffalo River.

Oral Report Evaluation Form
CSES 462v: Internship
35% of Course Grade

Speaker ____ **Date** _____________

Evaluator ____

Points **Comments**

_____ **Title** (5 points)
Identifies the Subject
Indicates the Purpose of the Presentation
Provides Keywords

_____ **Organization** (30 points)
Adequate Introduction
Objective Given
Ideas Developed in a Logical Order
Time Allotment Used Wisely
Clearly Stated Conclusion

_____ **Presentation** (30 points)
Professional Delivery
Appropriate Enthusiasm
Proper Grammar and Terminology
Eye Contact
Limited Distracting Mannerisms

_____ **Visual Aids** (25 points)
Clear and Appealing
Appropriate and Effective
Easily Interpreted
Communicated Topic

_____ **Subject Comprehension** (l0 points)
Ability to Answer Questions

_____ Total Points