**Institutional Effectiveness**
**2020-2021**

**Program:** Biology BS

**College and Department:** College of Arts & Sciences – Department of Biology

**Contact:** Christopher Brown

**Mission:** The primary mission of the Department of Biology at Tennessee Tech is to promote biological education in, and advance biological knowledge for, the region, state, and nation through teaching, research, and public service.

The Department of Biology has three degree programs (B.S. in Biology, B.S. in Wildlife and Fisheries Science, and M.S. in Biology). Each degree program has a separate report. Program Goals and Student Learning Outcomes for the undergraduate programs are similar since Wildlife and Fisheries Science is applied Biology; however, assessment results differ for most goals and outcomes based on the assessment techniques used. The graduate program has a unique set of goals and learning outcomes.
**Program Goals**:

PG 1: Increase the percentage of students in the Biology major who complete a cooperative program (“co-op”), experiential internship, and/or study abroad during their undergraduate years.

The goal is to have 10% of students in the Biology major complete one or more cooperative program ("co-op"), experiential internship, or study abroad opportunity during the time they are an undergraduate.

PG 2: Faculty in the Department of Biology will increase the incorporation of active-learning strategies in courses offered.

All departmental faculty members are expected to receive pedagogical training in active-learning techniques and strategies during their first 3 years of employment. We would like at least 75% of Department of Biology faculty to incorporate active-learning/critical-thinking strategies into their individual courses to improve the reasoning ability of our students.

PG 3: The Department of Biology will increase undergraduate retention.

Our goal is to increase the retention rate so that it equals or exceeds that of the university's average rate of retention.

PG 4: The Department of Biology will make significant progress toward increasing diversity.

The Department of Biology will make significant progress toward desegregation and affirmative action objectives.

**Student Learning Outcomes:**

SLO 1: Undergraduate Biology majors will demonstrate improved critical thinking skills.

Our goal is for students to meet or exceed the national average score on the California Critical Thinking Skills Test (CCTST).

SLO 2: Biology majors will participate in extracurricular activities related to their discipline.

Our goal is to have at least 25% of all Biology majors participate in extracurricular activities related to their discipline.

SLO 3: All students completing a degree in Biology at Tennessee Tech University will use scientific reasoning as codified by the structured process commonly known as the scientific method.

Our goal is to have all graduating seniors obtain a perfect score (100% correct answers) on the departmental Scientific Method Questionnaire.

SLO 4: Biology majors will be able to demonstrate a command of general biology concepts and the general principles in various specific areas of biology.

Our goal is to have our students perform above average in the ACAT Major Field Examination.

A departmentally developed curriculum map can be found in Appendix 1 that shows the connections between courses and student learning outcomes.

**Assessment Methods:**

*PG 1: Increase the percentage of students completing a co-op, internship, or study abroad*

1. Senior Questionnaire

Graduating seniors are asked to complete a short Senior Questionnaire (see Appendix) at the time they take their major field exam. As part of this they are asked to list any extracurricular activities in which they have participated, as well as assess how valuable they considered the experiences. One of the questions on the questionnaire is devoted specifically to internships and co-ops. The departmental chair tracks student internship participation rates through time. The departmental Planning Committee, consisting of five departmental faculty members selected by the department chairperson, continually revises the senior questionnaire to provide more detailed information about activities that are most valuable to undergraduate students.

*PG 2: Increase the incorporation of active-learning strategies in courses offered*

1. Faculty Annual Report

Conducted annually each Spring semester. Each faculty member submits a Faculty Annual Effort report to the chairperson that discusses their efforts for the previous calendar year. The departmental chair tracks the number of faculty participating in active-learning training and mentoring, and the incorporation of active learning/critical thinking strategies by gleaning such information from these reports.

The department chair discusses each individual faculty member's progress as summarized in Faculty Annual Reports**.** Active-learning is assessed by determining the number of Department of Biology faculty that enhance their knowledge of active-learning teaching approaches by participating in on- or off-campus training and development workshops devoted to such approaches. In addition, 100% of new Department of Biology faculty are paired with a faculty mentor who has experience with active-learning techniques in the classroom during their first year of employment. On-going progress on active learning/critical thinking implementation is summarized and included in the Departmental Annual Report submitted by the chair to the Dean of the College of Arts and Sciences.

2. Course Evaluation Reports

   Course Evaluations are administered in each class during Fall and Spring semesters. IDEA Evaluation Reports are used institution-wide and provide a mechanism for faculty to evaluate if they have achieved specific objectives in their respective courses. When completing IDEA Evaluation Forms, departmental faculty are encouraged to increase their selection of critical thinking and active learning objectives. The departmental chair and Planning Committee track these percentages from IDEA reports and provide feedback to the entire department at the start of each Fall Semester. In addition, the departmental chair and Planning Committee track percentages of students who responded with a "4" or "5" for items selected by faculty as important or essential in the "Progress Towards Goals" categories for teamwork, communication, and critical thinking.

*PG 3: Increase undergraduate retention*

1. Enrollment and Retention Rates

   Enrollment and retention rates are reviewed by the chair to acquire information on institution-wide enrollment, demographics, and retention. Enrollments are compared from year to year. Retention is assessed by comparing number of freshmen enrolled during fall and the following spring. Departmental retention is compared to the university-wide average.

*PG 4: Increase diversity*

1. Enrollment data disaggregated by gender and race/ethnicity

*SLO 1: Demonstrate improved critical thinking skills*

1. California Critical Thinking Skills Test (CCTST)

   The CCCTST is administered during Fall and Spring semesters to graduating seniors, and evaluates students' abilities to critically think based on skills that they have learned in their courses.

2. Select items on the National Survey of Student Engagement (NSSE)

   The NSSE was given Spring semesters 2006, 2009, 2011, 2014, 2017, 2020. The NSSE assesses students' abilities to work as a team, communicate, and critically think. These values will be compared to data from the senior questionnaire and results from IDEA evaluation reports.

The NSSE report changed how data are categorized from 2011 to 2014. As a result, the results provided for 2014 combines Biology in with Biochemistry or biophysics, Biomedical science, Botany, Cell and molecular biology, Chemistry; Earth science (including geology), Marine science, Mathematics, Microbiology or bacteriology, Natural science, Other biological sciences, Physical sciences (general), Physics, and Zoology. Therefore, the comparisons are not necessarily representative of Biology alone.

*SLO 2: Participate in extracurricular activities*

1. Select items on NSSE
2. Senior Questionnaire

*SLO 3: Use scientific reasoning*

1. *Scientific Method Exams:* Scientific Method Exams developed by the Biology Department are administered to students in selected classes that determine the degree to which students have learned the scientific method and to determine if they agree that our classes are adequately teaching the scientific method. Biology majors enrolled in two courses (a freshman course and an upper-division course) are required to complete a Scientific Method Exam at the end of the semester during which they take the courses. Results are evaluated by the departmental chair and the course instructors to determine the degree to which students have learned the scientific method and to determine if they agree that our classes are adequately teaching the scientific method. Comparisons are made for scores achieved by students in the freshman course and those achieved in the upper-division course.

*SLO 4: Demonstrate a command of general biology concepts and principles*

1. *ACAT Major Field Examination:* Administered each Fall and Spring semester. The ACAT exam breaks subject matter into a number of biological categories. We can select which categories should be used in evaluating our majors. These categories include bacteriology, cellular biology, ecology, genetics, botany, zoology, and evolution. This option is especially appealing because of the different focus of our program (i.e., organismal) from that of many other biology programs (i.e., molecular) in the state and nation.

   All graduating senior Biology majors are asked to take the ACAT Major Field Examination during the semester in which they intend to graduate. Scores are compared to the national mid-point range for the areas of bacteriology, cellular biology, ecology, genetics, botany, zoology, and evolution. The departmental chair tabulates scores and reports the results to the departmental Planning Committee at the start of each Fall semester.

**Results:**

*PG 1: Increase the percentage of students completing a co-op, internship, or study abroad*

Due to the pandemic, senior questionnaires were not administered in either Fall 2020 or Spring 2021. These are typically given at the same time as the major field exam is taken, but this exam was given online during the past academic year. We belatedly tried to get some responses via email in Spring 2021, but the return was poor (only 4 students, one of whom had completed an internship). We suspect that, due to the

pandemic, very few students were able to do an internship or co-op this past year, and study abroad was non-existent. Historically, we have fallen below our goal of 10% participation in these activities; internships in particular are pursued less often by biology majors that Wildlife & Fisheries Science majors in our department. Note that for 2018-2019 we had data only from Spring 2019, as the questionnaires from Fall 2018 had been misplaced. In addition, due to the COVID-19 pandemic, questionnaires were not given in Spring 2020, which accounts for the lower sample size.

Table 1. Percent of Biology graduates completing internship (BIOL 4900) or co-op assignment (n = number of students surveyed).

| Academic Year | Sample Size (n) | Percent (%) |
|---|---|---|
| 2016-2017 | 45 | 0.0 |
| 2017-2018 | 46 | 2.1 |
| 2018-2019 | 33 | 3 |
| 2019-2020 | 18 | 5.5 |
| 2020-2021 | NA | NA |

*PG 2: Increase the incorporation of active-learning strategies in courses offered*

The number of faculty participating in active-learning activities has remained consistent over the past five years (Table 2). Certain faculty, particularly the lecturers and instructor, are more likely to participate in these activities than either tenured or tenure-track faculty. All of the activities during the past year were either local to TTU (for example, through CITL or via CISE grants) or were virtual, as opportunities were limited due to the pandemic.

Table 2. Number of faculty (tenured, tenure-track, and lecturers) in the Department of Biology who reported that they had participated in active-learning workshops during the last five years.

| Academic Year | Sample Size (n) | Participants |
|---|---|---|
| 2016-2017 | 17 | 5 |
| 2017-2018 | 17 | 5 |
| 2018-2019 | 16 | 6 |
| 2019-2020 | 17 | 5 |
| 2020-2021 | 17 | 4 |

Over the past 5 years, very few faculty have *not* incorporated some form of active learning or critical thinking work in their courses, and for the first time this past academic year we had all faculty report such activity (Table 3). Most courses in our department have a laboratory component, and it's here that much of this type of learning occurs (through experiments, data analysis, and interpretation of results). Many upper-division classes use case studies, research papers/projects, and essay-type exams to test critical thinking. We have a relatively small proportion of faculty who have a "strong" active-learning structure in lecture, such as via a flipped classroom or active-learning components done each class meeting. However, many use class discussions as part of their courses, and during this past year more faculty than normal made use of Zoom or Microsoft Teams to have small group meetings and review sessions.

Table 3. Percent of Department of Biology faculty incorporating active-earning/critical-thinking strategies in their courses during the last five years.

| Academic Year | Sample Size (n) | Percent (%) |
|---|---|---|
| 2016-2017 | 21 | 95 |
| 2017-2018 | 20 | 95 |
| 2018-2019 | 19 | 95 |
| 2019-2020 | 17 | 94 |
| 2020-2021 | 17 | 100 |

From the IDEA course evaluation forms, the percentage of departmental faculty who select critical-thinking as either essential or important to their course has been above (or close to) our goal (50%) for four of the past five years (Table 4). As well, the percentage of faculty who select communication (an active-learning-associated goal) is above (or near to) our departmental goal of 25%. However, the percentage of faculty who select teamwork (another active-learning-associated goal) has consistently been below our goal of 25%, and was very low this year, likely due in part to many courses being taught online during the Fall 2020 semester. The five year averages for Biology in these categories were 17.7% for teamwork, 24.3% for communication, and 53.5% for critical thinking.

Table 4. Percent of IDEA course evaluation forms where Department of Biology faculty selected critical-thinking and active-learning objectives as essential or important during the last five years.

| Academic Year | Teamwork | Communication | Critical-Thinking |
|---|---|---|---|
| 2016-2017 | 22.2% | 18.9% | 66.7% |
| 2017-2018 | 14.0% | 25.0% | 32.0% |
| 2018-2019 | 20.3% | 26.7% | 54.2% |
| 2019-2020 | 18.4% | 23.7% | 46.8% |
| 2020-2021 | 13.6% | 27.4% | 68.0% |

*PG 3: Increase undergraduate retention*

After falling for several years, enrollment in the Biology major has increased each of the past two years (Table 5). Enrollment in the Health Sciences concentration makes up nearly half of this, at approximately 43%; other popular concentrations include zoology, microbiology, and cellular/molecular biology. Departmental retention rates are slightly below that of the university as a whole, but overall approach or exceed 85% across the past five years. Departmental retention rates have also been trending upward over the past several years.

Table 5. Number of students enrolled as Biology majors and freshman fall-to-spring retention rates (percent) for undergraduates within the Department of Biology and Tennessee Tech University. Retention rates for the Fall 2020 cohort were not yet available.

| Fall | Enrollment – Biology | Retention – Biology | Retention – TTU |
|---|---|---|---|
| 2016 | 316 | 86.3 | 92.4 |
| 2017 | 285 | 84.7 | 90.3 |
| 2018 | 294 | 86.4 | 91.3 |
| 2019 | 346 | 88.5 | 89.9 |
| 2020 | 401 | - | - |

*PG 4: Increase diversity*

A slow increase in minority students occurred in the B.S. Biology degree program until 2018, followed by a slight decline (Table 6). However, by raw counts the number of minority students has increased consistently during this period. Over the last five years, over 60% of all undergraduate Biology majors have been females, with the exception of 2016. Currently, 260 of 401 Biology majors are female. Thus, while our gender diversity is generally good and has remained relatively stable at a higher number of female students, our minority diversity remains somewhat low.

Table 6. Percent of Biology majors as minorities and females during the last six years.

| Fall | Minorities (%) | Females (%) |
|---|---|---|
| 2016 | 11.7 | 59.2 |
| 2017 | 12.3 | 62.8 |
| 2018 | 15.6 | 66.3 |
| 2019 | 14.2 | 62.8 |
| 2020 | 13.2 | 64.8 |

*SLO 1: Demonstrate improved critical thinking skills*

Average scores on the California Critical Thinking Skills Test (CCTST) for Biology majors have consistently exceeded the national average over the past five years (Table 7).

Table 7. Average score for Biology majors and sample size (*n*) on the California Critical Thinking Skills Test (CCTST) during the past five years. NOTE: The test moved from a 34 point maximum score to a 100 point maximum score in 2018-2019.

| Academic Year | TTU Biology | *n* | National |
|---|---|---|---|
| 2016-2017 | 16.7 | 82 | 16.2 |
| 2017-2018 | 18.0 | 48 | 16.2 |
| 2018-2019 | 79.0 | 47 | 74.0 |
| 2019-2020 | 75.0 | 41 | 74.0 |
| 2020-2021 | 74.2 | 32 | 74.0 |

NSSE 2020 data were aggregated by math and natural sciences, and did not separate out Biology majors. Thus, this data is not reported. If non-aggregated data becomes available, this will be updated.

To provide a more meaningful understanding of how students perceive if the goals of teamwork, communication, and critical thinking (per Program Goal 2) are being met, the number of courses that

at least 50% of the students rated with a “4” or “5” was calculated (Table 8). Roughly half of departmental courses are perceived by students to emphasize teamwork over the past four years, although this value was lower in the 2020-2021 academic year, perhaps due to more online learning being done. The same is true for communication, although with a less-steep decrease in the past year. For critical thinking, over the past three years closer to 75% of our courses are perceived by students to emphasize this skill.

Table 8. Percent of Biology Department courses that undergraduate Biology students rate more than 50% of the time with a “4” or “5” in the “Progress Towards Goals” categories for teamwork, communication, and critical-thinking over the last five years.

| Academic Year | Teamwork | Communication | Critical-Thinking |
|---|---|---|---|
| 2016-2017 | 75.0% | 82.4% | 95.0% |
| 2017-2018 | 48.0% | 40.2% | 63.1% |
| 2018-2019 | 51.0% | 46.8% | 71.9% |
| 2019-2020 | 49.5% | 52.4% | 73.4% |
| 2020-2021 | 41.2% | 47.6% | 79.5% |

*SLO 2: Participate in extracurricular activities*

As mentioned earlier, senior questionnaires were not given in Fall 2020 due to the pandemic, and few were returned in Spring 2021 as they were emailed to students instead of being done in person. These data are presented as part of Table 9, but given the low sample size will not be discussed as part of the overall trends. During the four years preceding 2020-2021, an average of 93.6% of graduating Biology majors indicated that they participated in extracurricular activities while at TTU, and over half (average = 70.0%) indicated that these experiences contributed positively to their education (Table 9). The pandemic has obviously affected some of these numbers over the past several years, particularly internships and attendance at scientific meetings.

Table 9. Percent of graduating Biology majors participating in extracurricular activities related to their discipline by academic year.

| | 2016-2017 (N=68) | 2017-2018 (N=47) | 2018-2019 (N=33) | 2019-2020 (N=18) | 2020-2021 (N=4) |
|---|---|---|---|---|---|
| Ext-Cur. Activities | 92.6% | 93.6% | 93.9% | 94.4% | 100% |
| Clubs | 35.3% | 38.3% | 48.5% | 55.6% | 75% |
| Internships | 0.0% | 2.1% | 3.0% | 5.5% | 25% |
| Sp. Topics | 29.4% | 25.5% | 30.3% | 38.9% | 25% |
| Sci. Mtg. | 26.5% | 38.3% | 39.4% | 16.7% | 0% |
| Seminars | 76.5% | 89.4% | 60.6% | 83.3% | 50% |
| Other | 20.6% | 42.6% | 36.4% | 50.0% | 25% |
| Positive Contribution | 73.5% | 85.1% | 54.5% | 66.7% | 75% |

*SLO 3: Use scientific reasoning*

The Department of Biology Scientific Method Exam was used to assess knowledge of scientific reasoning (Table 10). Both freshman, in our BIOL 1000 course, and juniors/seniors, in our BIOL 3920 course, perform well on this test, indicating that students arrive at TTU with a good knowledge of the scientific method. Improvement from freshman to upper-level students is seen each year, both in average scores and in the percentage of students who score at or above 90%. Our goal of all upper-division students scoring 100% on this exam has not been reached in any of the past five years, and it is more typical that 40-50% of students achieve this score.

Table 10. Student performance (percent) on the scientific method exam administered to students in BIOL 1000 (freshman course) and BIOL 3920 (upper division).

| | Average Score (%) | | 100% Correct (%) | | > 90% Correct (%) | | < 70% Correct (%) | |
|---|---|---|---|---|---|---|---|---|
| Year | 1000 | 3920 | 1000 | 3920 | 1000 | 3920 | 1000 | 3920 |
| 2016-2017 | 74.1 | 89.2 | 14.1 | 52.3 | 18.8 | 63.6 | 43.8 | 13.6 |
| 2017-2018 | 78.2 | 86.7 | 17.1 | 36.8 | 23.2 | 52.9 | 26.8 | 16.2 |
| 2018-2019 | 74.4 | 86.9 | 19.4 | 40.7 | 37.5 | 57.1 | 25.0 | 11.0 |
| 2019-2020 | 75.2 | 88.5 | 18.9 | 46.2 | 28.3 | 62.7 | 26.6 | 11.5 |
| 2020-2021 | 73.9 | 91.4 | 16.4 | 52.9 | 30.8 | 66.7 | 29.7 | 3.9 |

*SLO 4: Demonstrate a command of general biology concepts and principles*

Our majors general performed higher in some areas (e.g., ecology, botany, cell biology) and consistently lower in others (e.g., evolution, bacteriology, zoology) (Table 11). Overall, our students fall below the median percentile in all areas when averaged over the five years. The most recent academic year saw a marked improvement in some areas (bacteriology, cell biology, genetics) compared to the 2019-2020 cohort, and all three of these areas saw our students score above the national median percentile. The remaining areas saw declines from the previous year. Data from the Spring 2020 cohort were not included; these exams were given online due to the COVID-19 pandemic, and very few students (<5) took them using this format. Exams were also given online during the 2020-2021 academic year, and this may have affected results, although positively or negatively is difficult to determine.

Table 11. Results of the ACAT Biology Exam during the last five years.

| Year & Sample Size | Bacteriology | | Cellular Biology | | Ecology | | Genetics | | Botany | | Zoology | | Evolution | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Score | %tile | Score | %tile | Score | %tile | Score | %tile | Score | %tile | Score | %tile | Score | %tile |
| 2016-2017 (n = 49) | 483 | 43 | 488 | 45 | 488 | 45 | 488 | 45 | 471 | 39 | 468 | 37 | 478 | 33 |
| 2017-2018 (n = 47) | 489 | 46 | 506 | 52 | 509 | 54 | 516 | 56 | 498 | 49 | 481 | 41 | 484 | 43 |
| 2018-2019 (n = 16) | 470 | 38 | 455 | 33 | 453 | 32 | 442 | 28 | 480 | 42 | 499 | 50 | 462 | 35 |
| 2019-2020 (n = 22) | 480 | 42 | 495 | 48 | 502 | 51 | 465 | 36 | 508 | 53 | 492 | 47 | 499 | 50 |
| 2020-2021 (n = 32) | 501 | 50 | 513 | 55 | 493 | 47 | 509 | 54 | 494 | 48 | 471 | 39 | 450 | 31 |
| AVG (n = 166) | 484.6 | 43.8 | 491.4 | 46.6 | 489.0 | 45.8 | 484.0 | 43.8 | 490.2 | 46.2 | 482.2 | 42.8 | 474.6 | 38.4 |

**Modifications for Improvement:**

I will note that our department plans a thorough review of all goals and outcomes this academic year. We just completed our five-year program review, and the reviewers made a number of comments and suggestions related to what we report, and ways to improve or modify what data we gather and how we gather them.

*SLO 4: Demonstrate a command of general biology concepts and principles*

Student scores on the Evolution section of the ACAT exam are generally at or near the bottom of the 7 sections with this year's results being well below others. We have discussed adding an Evolution course to the program of study for our biology majors, both as a response to this and due to a general feeling that this subject is lacking in our curriculum. We have been unable to add this course in the past, due mainly to the fact that we've been short 1-3 faculty positions over most of the past 5 years. We will fill both of our remaining lines this academic year, and thus start offering this course in either 2022-23.

**Appendices**

1. Biology BS Curriculum Map
2. Senior Questionnaire
3. Scientific Method Questionnaire

## Appendix 1: Biology BS Curriculum Map

| | | Learning Outcomes | | | |
|---|---|---|---|---|---|
| Course No. | Title | Critical Thinking | Extra-curricular Activities | Scientific Method | Demonstrated Knowledge |
| BIOL 1000 | Intro. to Biol. Methods | X | X | X | |
| BIOL 1010 | Introduction to Biology | X | | X | X |
| BIOL 1020 | Diversity of Life | X | | X | X |
| BIOL 1080 | Concepts of Biology | X | X | X | X |
| BIOL 1113 | General Biology I | X | | X | X |
| BIOL 1123 | General Biology II | X | | | X |
| BIOL 2010 | Human Anat. & Phys. I | X | | X | X |
| BIOL 2020 | Human Anat. & Phys. II | X | | X | X |
| BIOL 2310 | General Botany | X | X | | X |
| BIOL 2350 | Intro. Anat. & Phys. | X | | | X |
| BIOL/WFS 2991-4 | Topics | | | | X |
| BIOL 3040 | Comparative Vert. Anat. | X | | | X |
| BIOL 3120 | General Ecology (no lab) | X | | X | X |
| BIOL/WFS 3130 | General Ecology | X | | X | X |
| BIOL 3140 | Cellular Biology | X | X | X | X |
| BIOL 3200 | General Microbiology | X | | X | X |
| BIOL 3230 | Health Science Microbiol. | X | | X | X |
| BIOL 3240 | Field Botany | X | | X | X |
| BIOL 3330 | Entomology | | | | X |
| WFS/CJ 3500 | Wildlife Law Enforcement | | X | | X |
| BIOL 3530 | Animal Physiology | X | | | X |
| BIOL 3700 | Humanism in Medicine | X | | | X |
| BIOL 3810 | General Genetics | X | | X | X |
| BIOL 3920 | Biol. Comm. Skills | X | X | X | X |
| BIOL 4000 | General Parasitology | X | | | X |
| BIOL 4040 | Immunology | X | | | X |
| BIOL 4060 | Hormones/Chem. Comm. | X | | | X |
| BIOL 4100 | Evolutionary Biology | X | X | X | X |
| BIOL 4130 | Enviro. Microbiology | X | | X | X |
| BIOL 4140 | Pathogenic Bacteriology | X | | | X |
| BIOL 4150 | Molecular Genetics | X | | | X |
| BIOL 4160 | Genetic Engineering Lab | | | | X |
| BIOL/WFS 4220 | Biostatistics | X | | X | X |
| BIOL/WFS 4230 | Animal Behavior | X | | | X |
| BIOL 4320 | Plant Physiology | X | X | X | X |
| BIOL 4330 | Plant Ecology | X | | X | X |
| WFS 4500 | National Wildlife Policy | X | | | X |

| | | | | | |
|---|---|---|---|---|---|
| BIOL 4610 | Invertebrate Zoology | X | | X | X |
| BIOL/WFS 4630 | Ornithology | X | | | X |
| WFS 4640 | Waterfowl Ecology & Mgt. | X | | | X |
| BIOL/WFS 4650 | Marine Biology | X | | X | X |
| WFS 4660 | Wild Bird Ecology | | | | X |
| WFS 4670 | Wild Mammal Ecology | | | | X |
| WFS 4700 | Habitat Management | X | | X | X |
| WFS 4710 | Fisheries Management | X | | X | X |
| WFS 4711 | Fisheries Mgmt. (no lab) | X | | | X |
| WFS 4730 | Conservation Biology | X | X | X | X |
| WFS 4740 | Wildlife Principles | X | | | X |
| BIOL 4750 | Medical Microbiology | X | | | X |
| WFS 4760 | Fish Culture | X | X | | X |
| WFS 4770 | Nongame Species Mgmt. | X | X | | X |
| BIOL 4780 | Phycology | X | | X | X |
| WFS 4790 | Wildlife Techniques | X | X | X | X |
| BIOL/WFS 4810 | Ichthyology | X | X | | X |
| BIOL/WFS 4820 | Mammalogy | X | X | | X |
| BIOL/WFS 4830 | Herpetology | X | X | | X |
| BIOL/WFS 4840 | Limnology | X | | X | X |
| BIOL 4850 | Applied Microbiology | X | | X | X |
| BIOL/WFS 4900 | Internship | | | | X |
| BIOL/WFS 4991-4 | **Advanced Topics** | X | X | | X |

**Appendix 2: Senior Questionnaire**

# GRADUATING SENIOR QUESTIONNAIRE

## Department of Biology

**1. Activities** - Please check any of the extracurricular activities in which you participated during your program at Tennessee Tech, and briefly indicate if you felt that these activities contributed to your academic development.

_____Beta Beta Beta active member

_____Chem-Med Club active member

_____Student Fisheries Association active member

_____Wildlife Society active member

_____Internship (BIOL/WFS 4900)

_____Special topics (BIOL/WFS 4990)

_____Attended one or more professional meetings

_____Attended special seminars or talks

_____Attended departmental sponsored activities not class related

Do you believe that your participation in these activities contributed to your academic development? If so, how? (Please leave this section blank if you did not participate in any of the above activities).

_____

_____

_____

**2.** **Classes** - List below required classes that you felt best contributed to your academic development and classes that contributed least to your development. What other classes do you think should be required of your major?

Most Important Classes: _____

_____

_____

Least Important Classes: _____

_____

_____

Other Classes that should be required: _____

_____

_____

**3.** **Other Suggestions** - Please provide any suggestions that you believe would improve the quality of education in your major. (Use the back if necessary)

_____

_____

_____

_____

_____

_____

Degree and Concentration: _____

**Appendix 3: Scientific Method Questionnaire**

Scientific Method Questionnaire

Please select the response that best completes the sentence or answers the question.

_____ 1._____, in which the experimental variable has been omitted, are used in research as standards of comparison against which experimental data are compared.

A. Theories B. Controls C. Hypotheses D. Observations E. Replicates

_____ 2. A_____is a tentative answer to a research question, which will be evaluated using an experiment.

A. Theory B. Control C. Hypothesis D. Experiment E. Law

_____ 3._____is the use of multiple observations in a study.

A. Hypothesis B. Control C. Theory D. Experiment E. Replication

_____ 4. True (A) or False (B): Science is knowledge obtained by observation.

_____ 5. True (A) or False (B): A theory is a very tentative idea with little or no scientific evidence to support it.

_____ 6. True (A) or False (B): Publishing results in a peer-reviewed journal is an important part of the scientific process.

Does oatmeal really reduce bad cholesterol? You decide to try to answer this question. You predict that people who eat oatmeal 5 times a week for a month will have lower cholesterol than those who don't. You select 10 people, 5 of whom you put on this oatmeal diet, and 5 of whom you don't. At the end of the month, you measure cholesterol in all 10 people.

_____ 7. The statement "Oatmeal reduces bad cholesterol levels" is the _____of this research.

_____ 8. Using more than 1 person in each group illustrates the concept of_____.

_____ 9. Using a group of people who do not eat oatmeal illustrates the concept of_____.

A. Observation B. Control C. Hypothesis D. Experiment E. Replication

Please arrange the following steps of the scientific method in the correct order.

_____ design an experiment

_____make observations

_____publish results

_____formulate research hypothesis

_____ draw conclusions

_____collect data