1. Assessment information collected

A set of Intended learning outcomes for the Biological Sciences BS and BA degrees was formally adopted by the faculty in 2012 and is accessible on the Biology & Wildlife website (http://www.bw.uaf.edu/undergraduates/pdf/bio_learning_outcomes.pdf). Major outcomes are reviewed below.

1.1. Knowledge

The Biological Sciences program intends their graduates to possess knowledge of core biological concepts, including evolution, inheritance and the expression of genes, cellular and organismal structure and function, and biologically-relevant pathways and transformations of energy. The Biology & Wildlife Department assesses the knowledge of Biological Sciences majors using the Educational Testing Service’s Biology Major Field Test (Biology MFT) (http://www.ets.org/mft). The test has been administered every semester since 2010 to all majors enrolled in a required, senior-level course, Principles of Evolution (BIOL F481). The Biology MFT is designed to assess the “mastery of concepts, principles and knowledge by graduating Biology students” (ETS). It consists of 150 multiple-choice questions covering the four major biology subject areas (Table 1). Our aim is to score in the top 50th percentile of participating institutions for all major subject areas.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Percent of Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Biology</td>
<td>21</td>
</tr>
<tr>
<td>Molecular Biology and Genetics</td>
<td>20</td>
</tr>
<tr>
<td>Organismal Biology</td>
<td>33</td>
</tr>
<tr>
<td>Population Biology, Evolution and Ecology</td>
<td>26</td>
</tr>
</tbody>
</table>
1.2. Competence

1.2.1 Communication and Information Literacy

Graduates in Biological Sciences are expected to communicate clearly and accurately about biological issues in both oral and written form. In particular, the department aims to graduate students who can argue cogently from evidence, write a report describing the findings of a simple biological study in the format of a scientific paper, and give an effective oral presentation on a biological subject.

One gauge of our majors’ ability to communicate biology is the successful completion of oral and written intensive courses in biology. All communication-intensive courses in biology require students to access and interpret literature sources, thereby providing instruction in information literacy as well.

Starting in Fall 2013, a capstone project requirement was adopted by the Biology & Wildlife Department to apply to all Biological Sciences majors (BS and BA programs). The capstone provides a second way to assess communication in the discipline. The capstone is a faculty-mentored research project chosen by the student and communicated in written and (additionally and optionally) in oral form. All capstone projects are assessed using a common rubric (http://www.bw.uaf.edu/undergraduates/capstone.php) that includes assessment of the quality of written communication.

1.2.2 Quantitative Analysis

Biological Sciences majors must be able to apply quantitative approaches to problem solving in biology. Like biological knowledge, the quantitative proficiency of Biological Sciences majors is assessed using the ETS Biology Major Field Test. Approximately 25% of the Biology MFT’s 150 questions evaluate the student’s analytical skills, as well as their biological knowledge. Content covered by the test includes: experimental design; inductive reasoning; application of data to problem solving; units of measure; probability theory and statistics; and interpretation of graphs, tables, and statistical analyses.

As of Fall semester 2013, quantitative proficiency is also assessed as part of the capstone project. The analysis and interpretation of data is a required component of the capstone project and is formally assessed as part of the standard rubric.
1.2.3 Technical Skills

Biological Sciences majors are expected to be competent in basic laboratory skills and techniques. Instruction on the use of essential biological tools and practices is integrated into the laboratory exercises of three lower division courses required by all Biological Sciences majors: Fundamentals of Biology I and II (BIOL F115X and F116X) and Principles of Genetics (BIOL F260). Within these courses, TAs provide informal, formative assessment of technical proficiency. There is no formal, summative assessment of this outcome.

1.2.4 Collaboration

Biological Sciences majors are expected to collaborate effectively, leading to a productive outcome. Training in effective collaboration begins in the Fundamentals of Biology series (BIOL F115X and F116X), in which collaboration is a required component. Across the two courses, students complete a total of four collaborative research projects. For each, students develop a group contract as part of their project plan. TAs review the plan, track the collaborative skills of the students, and provide formative assessment in the form of feedback. At the end of the project, students enforce their group contracts and may impose penalties on group members who did not collaborate effectively, adding a summative component to the assessment.

1.3 Critical and Creative Thinking

Biological Sciences graduates should be able to apply their knowledge, scientific literacy, and quantitative, technical, and communication skills to solve problems in biology through application of the scientific method. Prior to Fall semester 2013, the department had no formal means of assessing whether biology students could integrate the components of their education in this manner, although the number of major engaging in undergraduate research projects (BIOL F397, F497, F490 and URSA courses) provided a rough gauge of engagement in science. The need to challenge students to think both critically and creatively and to evaluate the students’ ability to integrate disparate parts of their education to generate new knowledge were major motivations behind the adoption of the capstone project requirement (summarized in section 1.2.1). Student projects are assessed with respect to 12 criteria, including study design, critical review of the relevant scientific literature, logical interpretation of the results, and effective communication. Evaluation forms and titles for all projects will be archived by the Biology & Wildlife department.
2. Conclusions drawn from the information summarized above

2.1 Knowledge

In 2013, approximately 500 colleges and universities administered the ETS Biology Major Field Test nationwide, including some of UAF’s peer institutions. The test therefore provides an objective assessment of the knowledge of UAF biology majors relative to a broad range of other institutions. The performance of UAF students on the Biology MFT across time, expressed as institutional percentile scores, is shown in Fig. 1. Three main patterns are evident.

First, Biology MFT results indicate that on average UAF Biological Sciences majors are proficient in biology relative to students at other participating institutions. UAF exceeds the 50% minimum target for most combinations of subject area and semester. Across all 8 semesters for which data are available, UAF scored on average at the 76th percentile, and between fall 2013 and spring 2014, UAF scored on average at the 67th percentile. Students tested highest in the area of ecology and evolutionary biology, which is to be expected because the test is administered near the end of an evolution course. Students tested lowest in organismal biology, including diversity and animal and plant physiology.

Second, in general, there were strong correlations between the scores achieved by individual students on different subject areas of the test (0.6 < r < 0.7). In other words, it was rare for a student to excel in one subject area while doing poorly in others. As a result, the total percentile score is generally a good representative of student performance across subject areas.

Third, there was considerable variability in student performance from semester to semester. Both low (<50th) and high (>75th) institutional percentiles for total scores occurred just during the two most recent years. Interestingly, much of this variation was associated with the type of instructor who taught the course in which the test was administered. Total institutional percentiles were, on average, 15% higher when the instructor was a full-time member of the faculty (blue bars on Fig. 1) rather than an adjunct (grey bars), a statistically significant difference (t = 3.8, df = 6, P = 0.01, n = 8 semesters). While it is not surprising that the instructor of the evolution course might affect student scores on the ecology & evolution portion of the exam, an instructor effect on performance in more disparate subject areas, such as cell and organismal biology, was unexpected. Full time faculty, by virtue of their teaching experience and knowledge of the student body may be better able to design challenging courses with high student engagement than adjuncts, who tend to have less experience. Administering the MFT in a setting where students are used to being intellectually challenged and engaged may result in their putting more effort into the recall of information from other courses. In addition, full time faculty may better appreciate and more successfully communicate to students the importance
of the MFT exam relative to adjunct faculty. It is impossible to disentangle the general effect of full time vs. adjunct faculty from the effect of individual instructor, because while three adjuncts taught the course, only a single full time faculty member taught the course since the MFT test was adopted (Dr. P. Doak).

Fig. 1. Institutional percentile scores for UAF on the Biology MFT by semester. Scores are reported as total and sub-scores for each subject section. Number of students in each cohort is shown at the top of the panel. Dashed lines indicate the 50th percentile. Solid lines show UAF’s overall institutional mean. Blue bars denote semesters during which the instructor administering the test was a full time tenured faculty member; gray bars denote semesters during which the instructor was adjunct.
2.2 Competence

2.2.1 Communication and Information Literacy

The number of Biological Sciences majors completing communication-intensive courses within the discipline of biology increased considerably over past two years. Students enrolled in W courses with a BIOL designator increased from 40 during AY 2010/11 – 2011/12 to over 100 during the past two most recent years (Table 2). Similarly, the number of students enrolling in O and O/2 courses with a BIOL designator rose from 88 to over 107 over the same time period. In part this change is due to an increase in the number of communication-intensive biology courses available in biology. In addition, as of Fall semester 2013, the Biological Sciences curriculum now requires some portion of a major’s communication-intensive courses be completed within biology.

The success of students in communication-intensive courses was high, with approximately 94% of students earning grades of C or better. (A grade of C or better is required for the course to count toward degree completion in Biological Sciences.)

Table 2. Number of Biological Sciences majors taking and passing (with C or better) communication-intensive courses with a BIOL designator in AY 2012/13 and AY 2013/14.

<table>
<thead>
<tr>
<th>Type</th>
<th>Number enrolled</th>
<th>Number Earning C or Better</th>
<th>% Earning C or Better</th>
</tr>
</thead>
<tbody>
<tr>
<td>W courses</td>
<td>106</td>
<td>101</td>
<td>95%</td>
</tr>
<tr>
<td>O courses</td>
<td>42</td>
<td>39</td>
<td>93%</td>
</tr>
<tr>
<td>O/2 courses</td>
<td>65</td>
<td>61</td>
<td>94%</td>
</tr>
</tbody>
</table>

Because the capstone was only initiated fall 2013, few students in the program have completed a capstone project. Twenty students completed projects within designated capstone courses, all with passing grades, and a single student submitted an approved capstone project paper based on mentored research in the lab of a faculty member.

2.2.2 Competence: Quantitative Analysis

Results of the Analytical Skills portion of the ETS Biology MFT exam indicate that Biological Sciences majors can demonstrate high proficiency in quantitative
analysis when properly motivated. Across the 8 semesters of data, UAF scored on average at the 73rd percentile of institutions (Fig. 2). Across the four most recent semesters, UAF scored on average at the 68th percentile. Like the biology subject test results, Analytical Skills scores were highly variable among semesters, with students scoring higher when the test was administered by a full time faculty member (blue bars) than when it administered by an adjunct faculty member (gray bars).

![Graph showing Institutional percentiles for UAF on the Analytical Skills portion of the Biology MFT exam between 2010 and 2014. Dashed line indicates the 50th percentile. Solid line shows UAF’s overall institutional mean. Blue bars denote semesters during which the instructor administering the test was a full time tenured faculty member; gray bars denote semesters during which the instructor was adjunct.]

2.2.3 Technical Skills

Basic biology laboratory techniques and practices are taught in Fundamentals of Biology (BIOL F115X and F116X) and Principles of Genetics (BIOL F260). The numbers of students passing these courses during the period of record is shown in Table 4.
Table 4. Percent of students receiving a C grade or better in required, lower-division biology courses with labs.

<table>
<thead>
<tr>
<th>Course</th>
<th>F 2012</th>
<th>S 2013</th>
<th>F 2013</th>
<th>S 2013</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL F115X</td>
<td>72% (117)</td>
<td>-</td>
<td>62% (99)</td>
<td>-</td>
<td>74% (216)</td>
</tr>
<tr>
<td>BIOL F116X</td>
<td>-</td>
<td>63% (87)</td>
<td>-</td>
<td>88% (68)</td>
<td>74% (155)</td>
</tr>
<tr>
<td>BIOL F260</td>
<td>92% (48)</td>
<td>100% (26)</td>
<td>94% (71)</td>
<td>na</td>
<td>94% (145)</td>
</tr>
</tbody>
</table>

na – data not yet available

2.2.4 Collaboration

Training and assessment in effective collaboration begins in Fundamentals of Biology I and II (BIOL F115X and F116X). The numbers of students completing these courses during the period of record is shown in Table 4.

2.3 Critical and Creative Thinking

Because the capstone was initiated in fall 2013, most students in the program have not yet completed a project. As detailed above, 21 students have completed capstone projects during AY 2013/14, all of which were adequate or better.

During the two-year period of record, 32 Biological Sciences majors completed independent projects through BIOL 197 – 497 designators (70 credit hours total), and an additional 4 students competed BIOL 490 (Research Experience in Biology (12 credit hours). A total of 30 Biological Sciences majors participated in research through URSA. Biological Sciences majors comprised 45% of the 29 participants in 2014 Research Day.

3. Curricular changes resulting from conclusions drawn above

The Biological Sciences curriculum underwent extensive changes during the past two years. Many of these changes were motivated by needs identified during previous reviews. The department’s goals and the changes implemented to meet those goals are summarized in Table 5.
Table 5. Summary of the goals and changes implemented to the curriculum in AY 2012/13.

<table>
<thead>
<tr>
<th>Goal</th>
<th>Change implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide undergraduate majors the opportunity for more concentrated study in a sub-discipline of biological sciences, while ensuring that all students receive adequate breadth.</td>
<td>Added concentrations to the BS degree with requirements for biological breadth in the choice of electives.</td>
</tr>
<tr>
<td>Assist students to obtain the minimum number of upper division course credits.</td>
<td>Revised the requirements for both BS and BA degrees.</td>
</tr>
<tr>
<td>Improve communication skills relevant to the biological sciences, including writing scientific papers and delivering oral or poster presentations on biologically-relevant topics.</td>
<td>Required that a portion of a student’s communication-intensive courses be biology-related. Required that each student communicate adequately the results of a capstone research project prior to graduation.</td>
</tr>
<tr>
<td>Assess more effectively the students’ ability to integrate knowledge, information literacy, technical skills, and communication by completing a scientific project.</td>
<td>Required that each student adequately design, implement, interpret, and communicate a biological capstone research project prior to graduation.</td>
</tr>
</tbody>
</table>

While performing well overall, Biological Sciences majors were relatively weak in their knowledge of organismal biology relative to other subject areas on the Biology MFT. Under the revised Biological Sciences curriculum adopted in 2013, BS students are now required to consider subject area breadth when choosing electives and must take courses in organismal biology and physiology in most curricular tracks. The department is also considering a new, upper-division course in advanced human pathophysiology that will attract majors with health-related interests and could potentially improve student performance in this area.

To help students obtain communication skills relevant to the major, we have increased the number of W and O-designated courses in biology. Over the past two years, two new courses were adopted, Research Experience in Biology (BIOL F490W) and Metabolism and Biochemistry (BIOL F403W), and communication-intensive designators were added to three existing courses, Ecosystem Ecology (BIOL F476O), Mammalogy (BIOL F425W), and Global Change Biology (BIOL F85W).

We anticipate that the capstone project will become a powerful educational and assessment tool in the coming years. The faculty has recently refined the requirement, on the basis of experiences during AY 2013/14. The original description stated that a
student could satisfy the capstone requirement by passing a capstone course. While convenient, this rule potentially allowed students to pass a capstone course while failing to produce an adequate capstone project, and vice versa. In the future, the capstone project requirement may be satisfied only by receiving an adequate evaluation on the capstone project itself, independent of the course grade. A list of students satisfying the capstone requirement will be communicated to the Registrar by the Biology & Wildlife chair at the end of each semester.

The number of students taking capstone courses will increase in the future, and providing a sufficient number of such courses in a variety of subject areas, as well as providing sufficient assistance to students in these courses, will be challenges over the next two years.

4. **Identify the faculty members involved in reaching the conclusions drawn above and agreeing upon the curricular changes resulting**

Patricia Doak
Syndonia Bret-Harte
Kris Hundertmark
Jeremy Jones
Denise Kind
Andrej Podlutsky
Diane Wagner