Dec 22, 2005
Final draft

Biology Department

Program Review
2004-2005 Academic Year

Natural Sciences Division Chair: Robert Neher, PhD
Biology Department Chair: Jeffery Burkhart, PhD

Executive Summary

The Biology Department offers both BA and BS degrees in biology, and BA degrees in Biology-Teaching Track, Environmental Biology, Environmental Management and Natural History. A majority (90%+) of the majors coursework is taught by full-time faculty, whose collective competencies cover that expected for a university level major in the biological sciences. Degree requirements are similar to comparison institutions, and majors are required to complete a senior project and pass an exit exam to graduate. The number of majors over the past five years has fluctuated between 58 and 84, but is projected to increase over the short term. Ethnic diversity is high and typical of the ULV student population. The majority of majors are advised by full-time faculty and mean class size for major level courses is about 17.

The learning outcomes for the various biology majors include knowledge and understanding of theory, research and application, awareness of issues of sustainability and human impacts on the global environment, and adequate preparation for graduate school and careers.

The assessment procedures included an alumni survey, a senor exit survey, senior exam performance, grade distributions, focus groups, faculty interviews, course evaluations, analysis of senior projects and syllabi, curriculum comparisons with other colleges, subject matter understanding and skills analysis, and critical thinking assessments.

The findings suggest the following:

1. Students receive a good foundation in theory and principles of biology, and realize significant enhancement of their critical thinking skills during their tenure as biology majors.

2. Strong departmental faculty commitment to environmental sustainability concepts, as well as alumni and stakeholder responses indicate that the goal of articulating the concepts of sustainability is being adequately met.

4. Students report satisfaction with acquired skills of knowledge, but performance on some graduate level competency exams (e.g. MCAT scores) suggest additional oversight is warranted.

5. Considerable effort is made by faculty to expose students to the primary literature of biology, but additional attention is warranted in oversight of preparation of the senior thesis.

6. Less than satisfactory senior project completion rates suggest re-evaluation of senor project expectations and the enhanced tracking of students in their senior thesis progress.

7. There is broad agreement that students receive good academic and career advisement.

8. Student dissatisfaction with science seminar suggests adjustments in the seminar format should be considered.

9. Comparisons to peer institutions suggest adjustments in faculty course load should be explored.

10. Low enrollments in the environmental management and natural history majors suggest rethinking of majors offered is warranted.

Recommendations for action include:

1. Rethink the senior project options and approach and offer a non-empirical option for students.

2. Consider adding a major in environmental studies major in place of environmental management

3. Update course offerings to better reflect recent retirements, and the competencies of recently hired faculty.

4. Rethink structure and presentation of science seminar.

5. Incorporate Montana Magpie Ranch into home campus programs

6. Work closely the admissions to aid in the recruitment of the highest quality majors possible.

7. Rethink course load expectations to reflect demands of student research support and the increased expectations for faculty research.

I. Program mission

The mission of the Biology Department is provide a biological foundation rich in theory, applications and values that will enhance the quality of life and ensure opportunities that will fulfill our student's professional aspirations. This will be achieved by offering the highest quality educational program for both traditional-aged and adult students.

II. Program Goals and Learning Outcomes

Biology majors will:

A. Acquire a foundation in the principles and theories of the biological and supportive sciences.

B. Be able to articulate the essential concept of environmental sustainability, and demonstrate an understanding of human impacts on the global environment.

C. Be able to apply and interpret the methodologies of science, and demonstrate skills in accessing, interpreting and evaluating biological literature

D. Design, implement, and prepare a formal report on the results of an independent research project or culminating senior experience.

E. Show competency in divergent areas of the biological sciences, including molecular/cellular, organismal, evolutionary and environmental sub-disciplines.

F. Receive good program and career related advising

G. Gain acceptance into appropriate graduate programs and/or obtain employment in a biologically related field if so chosen.

III. Program Description

A. Organization

The Department of Biology offers both B.A. and B.S. degrees in Biology, and B.A. degrees in Biology – Teaching Track, Environmental Biology, Environmental Management, and Natural History. Each major has a program chair that reports to the Department Chair. The Department, though autonomous, is contained within the Division of Natural Sciences and Mathematics, and the Department Chair reports to both the Division Chair as well as the Dean of the College of Arts and Sciences. This structure is unique to the University, and is considered to be a major reason for the very close and supportive working relationships enjoyed by the included Departments.

B. Faculty

Currently (2004-05) the Biology Department has 6 full-time, 2 half-time (teaching load), and three part-time (adjunct) faculty. Seven of the eight regular faculty have earned doctorates, and the eighth (J. Garcia) is ABD and expected to finish during Fall 2005. During the 2004-2005 academic year, adjunct faculty taught 7 (17%) of the 41 offered courses, significantly less than the Arts and Sciences mean of approximately 1/3. (Appendix A contains names of instructors and courses taught.)

Faculty competencies include expertise in zoological and botanical domains, cellular and molecular biology, and field biology – all areas considered essential for a Department of our size.

C. Courses and course enrollments

Over the past 5 years, with larger numbers of students matriculating into the biology program, there has been a gradual increase in course enrollment. Increases have been especially notable for BIOL 343 (Human Anatomy) and BIOL 344 (Human Physiology) reflecting the increased demand associated with the support of the Movement and Sports Science (MSS) program. During 2004-05, enrollments in 40% of BIOL courses exceeded that of any of the previous three years. We expect enrollments to continue to increase at least in the short-term.

Additionally, over the interval 2000-2005, 48% of students enrolled in Biology courses were enrolled in non-majors BIOL 101 or BIOL 374 (however, approximately ¼ of Biology majors take BIOL 374). Finally, during the 2000-2005 academic year, 61% of BIOL majors courses had mean enrollments exceeding 10 students**.** Enrollment numbers for course offerings during the interval Fall 2000 to Spring 2005 are contained in Appendix B.

Finally, in addition to BIOL 101 and 374, Departmental faculty teach a variety of GE support courses including CORE 340 (and, occasionally other CORE courses), and GNST 100. Since Fall 2000, full-time faculty have co-taught 35 of the 52 CORE 340 courses offered during the regular academic year.

D. Majors

The Biology major (either B.S. or B.A.) requires completion of 43-48 semester hours of BIOL courses and an additional 35 hours of supportive requirements (i.e. Chemistry, Math, Physics, Science Seminar). The Teaching-Track Major (B.A.) requires 41-45 semester hours of core requirements and an additional 32 hours of supportive requirements. The Environmental Biology major (B.A.) requires 51-55 semester hours of core requirements and 24 semester hours of supportive requirements. Finally, the Environmental Management major (B.A.) requires 57 – 60 hours of recommended core courses; 12 hours of recommended GE courses and an additional 8 hours of BIOL coursework

The Natural History major (B.A.) is similar to the Biology Major; however requirements for each student are worked out individually with the Program Chairperson. In recent years, this

major has been primarily an option for students that have been unsuccessful in negotiating some of the more rigorous math and chemistry requirements of the Biology major.

Completion of a written senior thesis, an oral presentation of the thesis work, and successful passage of a senior exam are required of all majors for graduation.

During Spring 2004, a Biology minor was initiated, principally to meet a demand from Movement and Sports Science, which requires 24 semester hours of Biology of which 16 must be upper division. Appendix U contains a listing of course requirements for the Biology Minor.

Recent enrollment and graduation numbers for the four biology majors are contained in Table 1. Not reflected here is the disappointing number of students that graduate late (or not at all), due to a failure to complete the senior project within a four-year time frame.

Table 1: Enrollment and graduation numbers for biology majors over the interval 2000-2004 (Source: ULV fact book). Additional data on graduation numbers in each of the biology sub-disciplines are contained in Appendix S.

	Years				
	F 2000	F 2001	F 2002	F 2003	F 2004
Majors					
Biology (inc. Teaching)	76 (5)	65 (10)	67 (6)	58 (12)	84 (9)
Environmental Biology	4 (1)	5 (1)	4 (3)	2 (1)	4 (1)
Environmental Mgnt	2 (0)	1 (0)	0 (1)	0 (0)	1 (0)
Natural History	0 (0)	2 (0)	0 (0)	0 (0)	2 (0)

Analysis of students graduating since 2000 (Appendix S) showed that 64% were female (Vs 66% reported for the 2004 Profile of College-Bound Seniors for California). Ethnicities were self-reported with 48% identified themselves as Caucasian, 28% as Hispanic, 14% as Pacific Islander/Asian and 6% as Black.

E. Advising

Traditional-age biology majors are normally advised by regular faculty members, however some receive their initial advising by Academic Support and Retention, the Learning Enhancement Center (if matriculating with deficiencies), or Honors faculty. During Fall 2004, 148 students (including CAPA, dual major and undeclared major students) were advised by Biology Department faculty. Of this total, eight-three were enrolled at ULV during Fall 2004, and the majority of the remaining 65 represented students that had failed to return to school, or who had not yet completed their senior research projects. Further, during Fall 2004, the

number of faculty advisee assignments ranged from 8 to 38, with a mean of 19**.** Nine percent (13) of students were advised by non-Departmental faculty or staff.

F. Field programs

The Biology Department has a long history of offering 'field' courses and the conducting of field research. Since 2000, the number and variety of field opportunities has broadened with the development of a January term tropical biology field course, and the now operational Montana Magpie Ranch Field Facility. During summer 2005, four Biology students spent three weeks in Montana working on a combined class/research project that will be continued in 2006 and future years, and additional programs are planned.

In addition to BIOL field courses, one CORE 340 field experience ('Community and Environmental Preservation of Kenya') was offered in 2002, and others are planned for the future.

IV. Assessing Student Attainment of Learning Objectives.

A. The following were used to assess learning outcomes:

1. **Alumni Survey**
   Alumni who graduated (or who had finished all requirements for graduation other than their senior project) from ULV with a biological sciences major during the interval 1995-2004 were contacted by mail and requested to participate in an alumni survey. A total of 120 former students were contacted, of which 40 (33%) responded either via mail or an on-line survey soliciting responses concerning their ULV experience. A copy of the survey and a summary analysis of responses are contained in Appendix M.

2. **Senior Biology Student Focus Group Survey**
   In March 2005, two trained ULV Psy-D students conducted a survey of 10 Biology seniors to evaluate their perceptions of Biology Department strengths, challenges, and opportunities. Their analysis is summarized in Appendix G.

3. **Syllabi Review**
   Dr. Jonathan Wright, Associate Professor of Biology, Pomona College was engaged to conduct a review of syllabi from non-major and majors BIOL courses taught by regular Departmental faculty. Dr. Wright's analysis of 16 syllabi for courses taught by eight Biology faculty is contained in Appendix C.

4. **Senior Project Analysis**
   Dr. Jonathan Wright of Pomona College was also contracted to conduct an evaluation of a random sampling of 17 senior project reports completed during the interval 2000-2004. His comprehensive report including recommendations is contained in Appendix D1. Appendix D2 contains a listing of Biology,

Environmental Biology and Environmental Management senior projects submitted between the 2000-2004 academic years.

5. **ULV Stakeholder SWOT Interview Analysis**
During March and April (2005) 20 interviews were conducted by Associate Dean Aghop Der-Karabetian of faculty, staff, and administrators that 'have knowledge of, and a working relationship with', the biology program. A copy of Dr. Der-Karabetian's summary report is contained in Appendix E.

6. **Science Seminar Analysis**
All junior and senior students in the Biology, Chemistry and Physics programs are required to attend a weekly seminar presented by faculty, outside invited speakers, or by students reporting on individual research projects. Additionally, attending students are required to evaluate each presentation, and submit the evaluations to the seminar coordinator. Brief summaries of student evaluations are contained in Appendix F.

7. **Senior Exam Performance**
To graduate, all biology students are required to successfully pass (with a score of 50% or better) a comprehensive exam given during their senior year. A summary analysis of exam pass rates and individual performance in different subject areas is contained in Appendix H.

8. **Program Comparison with Peer Institutions.**
The biological science programs of thirteen colleges and universities similar in size and mission to ULV were evaluated and compared in terms of degrees offered, faculty size, numbers of students, areas of concentration, and faculty teaching and research load. A summary of these comparisons is contained in Appendix I.

9. **Biology Senior Exit Survey**
During Spring 2005, eight senior biology students were formally surveyed regarding perceptions of their ULV educational experience. A copy of the survey and summaries of student responses are contained in Appendix J.

10. **Subject Matter Understanding and Skill in Biology Analysis**
To demonstrate appropriate subject matter understanding and skills, the State of California requires a skills analysis for coursework taken by students seeking teacher certification. Appendix K contains summary tables of this analysis.

11. **Field Programs and Coursework**
The ULV Biology Department enjoys a long tradition of offering field opportunities as part of the core biology curriculum. Appendix L contains a summary of recent field programming.

12. **Facilities and Equipment**
Sophisticated laboratory facilities and associated equipment and supplies are essential for adequate training of students of the biological sciences. Appendix N contains an accounting of equipment and facilities currently possessed, with proposed recommendations for future acquisitions and upgrades

13. **Grade Distributions**
Grade distributions for all BIOL courses from Fall 2000 to Spring 2005 compiled and examined **(**Appendix Q**).** The frequency and percentage of grades were aggregated across multiple sections of each course, and an overall mean calculated for BIOL majors and non-majors courses.

14. **Biology Course Enrollments 2000-2005.** Numbers of students enrolled in all BIOL courses offered on the main campus from F 2000 to S 2005 (including summer sessions) are contained in Appendix O. Additional data include catalog listed courses not offered over the interval 1995 – 2005, numbers of students enrolled in majors and non-majors BIOL courses and CORE 340 sections offered by departmental faculty.

15. **Examples of Professional Papers given by Students and Faculty.**
Appendix P contains a listing of professional papers given by faculty and students during the interval 2000 – 2004. Outcomes of selected grant submissions are also included.

16. **Examples of unsolicited letters and communiqués received from students.**
Biology faculty were asked to submit samples of letters received from graduated students that reflected perceptions of their training at ULV. Those submitted are contained in Appendix R.

17. **Graduates in Biology, Environmental Biology, Environmental Management, and Natural History 1994-2004**. Appendix S contains a listing of total numbers of students graduating over the past 11 years, and numbers of graduates in each of the four biology sub-disciplines (biology, environmental biology, environmental management, natural history) from 2000 to 2004. Additionally data on ethnicity and sex ratio are presented.

18. **Critical Thinking Assessment: Summary of 2004 Results from CAAP (Collegiate Assessment of Academic Proficiency)**. Appendix T contains a copy of a report prepared by Aghop Der-Karabetian summarizing the results of an investigation of critical thinking abilities of Freshmen and Senior Biology majors.

V. Findings

A. Learning outcome: Biology students will acquire a foundation in the principles and theories of the biological and supportive sciences. (Jay to complete)

A review of Biology curriculum and course syllabi indicates that the core principles and theories of the biological sciences are woven into the program in an integrated way, which provides appropriate scaffolding, reinforcement and depth. The initial exposure for first year students is in Biology 203, Principles of Biology. This course includes a systematic treatment of the nature of science, the domain of biology, cell and molecular principles, evolution and ecology, which are key core concepts. The cell and molecular aspects are reinforced in Biology 204 and 205, Plant and Animal Biology respectively. These courses build upon this foundation to add key knowledge of form, function, and diversity. Additional core courses, Cell and Molecular Biology, Genetics, Developmental Biology, Environmental Biology provide the depth of knowledge needed in these areas. Research Methods and Biostatistics, together with the Senior Project/Thesis help to reinforce scientific principles and methodology. The Biology faculty examined the coverage of core concepts carefully in conjunction with document preparation for the **State of California Teacher Licensing Commission (SCTLC) (**Appendix K). Although the analysis went beyond the SCTLC criteria, the subject elements recommended by the National Association of Biology Teachers, as shown in Appendix K, adequately demonstrates coverage of the core principles and theories, in our curriculum. Examination of the **curriculum of the comparable schools** surveyed in Appendix I, show that although there are some differences, all contain elements that provide a solid foundation in the principles and theories of the biological and supportive sciences.

The Biology Faculty recognizes the importance of supportive requirements. Biology students take a full year of General Chemistry including principles and Qualitative analysis. In the second year students take a full year of Organic Chemistry and a one semester comprehensive Biochemistry course. Biology students are tracked with Chemistry majors in these courses. The Chemistry courses are rigorous and conform to American Chemical Society standards. In addition, our students get more direct exposure to instrumentation than students at comparable institutions. This allows our students to apply theoretical concepts in real life situations. Although some Biology programs have reduced or eliminated Physics as a requirement, the faculty still require a full year of this fundamental science.

Anecdotal evidence indicates that the strong chemistry background and direct hands on experience with instrumentation, give our students a competitive advantage when applying for jobs and graduate programs.

Stakeholders expressed some concerns, which may bear relevance to providing the aforementioned foundation. Appendix E (**ULV stakeholder SWOT analysis**) records concern that some courses are not up-to-date, although the impact on this specific objective was not discussed. A second concern, which is supported by ULV admissions data, suggests that many students come to ULV poorly prepared and with unrealistic expectations. The majority of our students come to us lacking a solid high school level background in Biology and the supportive sciences. This puts an

additional burden on faculty who must help the students catch up in addition to providing the level of rigor needed to fulfill the mission. The overall grade point average for all majors, biology classes is 2.62 on a 4-point scale (**grade distributions,** Appendix Q). The Biology faculty feel that this somewhat low value is a function of this poor preparation. However, faculty feel strongly that the effectiveness of the program is high if judged in terms of value added. The results of a focus group composed of Biology seniors suggest that the faculty are very knowledgeable, and that the curriculum is very rigorous (**senior biology student focus group survey,** Appendix G), a perspective consistent with the above. The **senior exit survey** results (Appendix J) show strong marks for with regard to the provision of basic principles in the life and physical sciences with a mean of 3.5 on a 4-point scale. Critical thinking skills, knowledge of science processes received even higher scores. Exiting seniors also felt that supportive requirements useful in helping them in their major (3.13 / 4.0).

Performance on the **senior exam** (Appendix H) confirms that most of our students have a good grasp of the principles and theories of the biological and supportive sciences. Although a few need to retake the exam to achieve a passing score, most of our students pass it the first time through and very few are unable to pass the exam on subsequent tries. Analysis of the most recent results (Spring 2005) by area, suggests that students are getting a fairly well rounded background. with a mean high of 67% correct in the realm of Biochemistry and a low of 41% in Genetics. It is difficult to provide comparative data because the test instrument was revised from that delivered in prior years.

The ability to present material well in both an oral and written context are key components of the foundation we seek to provide. Presentation skills are first addressed in the Principles of Biology course and are reinforced in other courses. Science students have long held a reputation for delivering presentations that are among the best in the University. Evaluations of various aspects of presentation and content are typically around 3.5 on a 4-point scale, as rated by both faculty and peers (**science seminar analysis,** Appendix F).

Analysis of senior projects/theses suggests the quality is high, in general (s**enior project analysis,** Appendix D). Such performance suggests our students have mastered both the foundational principles and skills needed to conduct the research/project as well as to present it well in a written form. In an independent assessment, Biology student critical thinking skills were also judged to be the highest among all majors tested at ULV (**2004 Critical Thinking Assessment**, Appendix T). One criticism of the theses/project reports was the omission of statistics and shallow literature searches in several of the works examined. The recently added Research Methods and Biostatistics class should help resolve this issue. The use of statistics and appropriate literature will be addressed and assessed more thoroughly in future theses/project reports.

Perhaps the most important measure of whether we have met this objective is that of alumni. **Alumni survey (**Appendix M**)** items 12-14, measured how well alumni felt critical thinking, basics principles of biology, and science processes, were covered. All received scores greater than 3.2 on a 4-point scale.

Seventy percent of responding alumni went on to graduate or professional programs and most felt that they were well prepared by their training at ULV. Results from the next question indicated that alumni felt as prepared or better prepared when compared to those from other schools (i.e. 2.23 on a 3 point scale). Finally, over 80% of our alumni would choose ULV again if they had it to do over again.

In summary, the curriculum and culture of the Biology Department provides the foundation in principles and theories of the biological and supportive sciences that allows students to be competitive in graduate/professional school and the workforce. Students appear to be especially competitive with regard to direct experience with analytical methodology and instrumentation. Alumni feel they have been well prepared with regard to these fundamentals and that they made a good choice in attending ULV. Areas to improve include more selective recruitment, to reduce the number of students that are not prepared for a college level biology curriculum, and also early identification of those that are not doing well in the program, coupled with appropriate intervention.

B. **Learning outcome: Biology students will be able to articulate the essential concept of sustainability and demonstrate an understanding of human impacts on the global environment and its biota.**

One third (n = 36) of catalog listed BIOL coursework contains field experience components that expose students to the natural world. One of these, BIOL 312, Environmental Biology focuses specifically on sustainability concepts. Additionally, each January term a field course (**Field Programs,** Appendix L) with an environmental focus is offered, and during summers, there are opportunities for environmental study at the Montana Magpie Ranch facility. In 2005, 12 students participated in a January field experience, and in June 2005 four students spent three weeks working on field projects in Montana. Because of its distance, the Montana campus can only be utilized during summers; hence special efforts should and must be made to more effectively incorporate Montana programs into the curriculum. This need was emphasized by interviewed **SWOT stakeholders**, as was the initiation of new field courses.

Results of the **Alumni survey** (Appendix M) showed that 11 of 40 respondents participated in a January term field course. Further, alumni strongly supported (with means of 3.35 and 3.68 respectively of a 4 point scale where 4 = strongly agree) the statements that their ULV Biology training gave them an appreciation of the interdependence of humans and their environment, and that their lifestyle reflected what is necessary for creating a 'sustainable planet'.

Responses from the **ULV stakeholder SWOT analysis** (Appendix E) indicated that stakeholders perceive Biology faculty to be committed to concepts of sustainability, however one respondent indicated that 'Green campus' activities fail to get sustained attention, and suggested that students be utilized to do on-campus sustainability studies and make recommendations. This is a suggestion that could be considered by the Sustainable Campus Committee chaired by Robert Neher.

In recent years enrollment in the Environmental management program has waned (only four graduates between 2000 - 2005), and there has been some departmental discussion of either dropping the environmental management major, or changing it into an interdisciplinary environmental studies major. This environmental studies concept was also suggested by stakeholders in the **SWOT analysis,** and should be further explored.

Student performance on the **Senior exam** (Appendix H) indicates that graduates have a reasonably good, though not impressive, understanding of ecological concepts with 58% correct responses on environmental/ecological questions. This performance was approximately equal to the proportion of correct responses for other question areas, and should probably be better.

Some **SWOT stakeholders (Appendix E)** suggested that the heavy load of covering CORE 340 courses by biology faculty had the effect of 'taking away from departmental needs', one person made the recommendation to cover these sections with adjunct faculty. It is true that CORE 340 comprises a significant proportion of the departmental load; however faculty commitment to this course offers evidence of support for the concepts of sustainability and interdisciplinary teaching.

In summary, strong commitment of departmental faculty to environmental sustainability concepts, as well as alumni and stakeholder responses indicate that the goal of articulating the essential concepts of environmental sustainability and the demonstrating of an understanding of human impacts on the human environment is being adequately met. Areas in which additional attention is warranted include reworking of the environmental management major and refocusing attentions on the green campus effort.

C. Learning outcome: Biology students will be able to apply and interpret the methodologies of science and demonstrate skills in accessing, interpreting and evaluating biological literature.

A majority of the biology faculty in one or more of their courses require the accessing and reading of appropriate journal articles, and then a formal written summary and analyses of the article. Approximately half of all regularly offered biology courses require students to access, read, and critique primary journal articles. Students begin familiarizing themselves with primary literature in a semester-long scaffolding exercise in BIOL 203 that begins with an initial reading and review of secondary and tertiary (popular) science articles. After several weeks of practice, students then select an article (of their own interest) from the primary literature. The culminating activity is a poster presentation to the class and a formal paper discussing and evaluating the primary article. In BIOL 310, students experience journal clubs. The journal club format involves the entire class reading and discussing the same piece of primary literature, selected for its relevance to course material. As a group, the students and instructor interpret the data and critique the article. Subsequently, each student writes up her/his own critique based on instructor-given guidelines. Various other courses (BIOL 204, 205, 302, 313, 316, 322, 345, 346, 376, 379) require that students select, present, interpret, and critique in writing published research.

Interpretation of scientific literature is an important component of many biology courses; however two courses place special focus on evaluating the methodologies of science: BIOL 379, Research Methods and Biostatistics, and BIOL 499 Senior Seminar. BIOL 379 was introduced in 2000 with the goal of facilitating the successful planning and completion of the senor project requirement. Because of credit hour limitations to the biology curriculum, this course was initially limited to 1 unit, but subsequently was expanded to 2 units. Research methods and biostatistics emphasizes the honing of skills in literature review, experimental design, data analysis and scientific writing, and while successful in part, the 2-credit format still offers rather superficial coverage of topics such as inferential statistical analysis, and could be easily expanded to a 3-4 hour course. Alternatively, biology students could be encouraged to take a statistical methods course offered by one of the other departmental areas, such as Psychology**.**

"Research of the literature", was listed as an area of concern by Dr. Jonathan Wright (Pomona College) in his critique of Biology senior theses (**Senior project analysis,** Appendix D**),** hence the additional attention to the primary literature described above seems warranted. His major critique was that students relied too heavily on a few sources in preparing their literature review, and hence were too narrow in their coverage. With the enhanced access to primary literature through advances in library and on-line search engines, and clear guidelines outlining expectations on the extent of the literature review this deficiency is being addressed. Students enrolled in the BIOL 379 and BIOL 499 courses must be given clear expectations of the extent expected of their library research, and supervising faculty must be diligent in requiring such comprehensive coverage.

Faculty, staff, and administrators interviewed for the **stakeholder SWOT analysis** (Appendix E) highlighted the fact that many students struggle in their senior project experience. Too many fail to finish in a timely manner, if at all. The student research process has lacked structure/sustained oversight in part due to heavy faculty teaching loads, and in part due to poor tracking by faculty, which is largely an outcome of a heavy work load. Additionally, insufficient equipment and limited resources presents challenges to faculty and students who possess the motivation to engage in empirical research. Further stressing the time and facilities resources is an increased population of junior and senior level students coupled with a recent decline in the number of teaching faculty (from retirements and reassignments). These issues could be ameliorated by the development of a non-empirical project alternative such as the grant proposal option used by Pomona College, and it is recommended that such an option be considered.

ULV Biology faculty would like to have more time to engage in and provide more research support to students, however are saddled with heavy teaching responsibilities, having the highest teaching load of the seven comparison institutions selected for program comparison **(Comparison Institutions**, Appendix I**).** Further, faculty receive no teaching credit for mentoring students through their senior project experience, although such research mentoring requires substantial time and commitment. Additionally, by comparison, the ULV Biology Department has the smallest number of full-time faculty per the number of students served. Thus, time commitment to teaching prevents many faculty from devoting additional attention to juniors and seniors learning to access, interpret, and evaluate biological literature.

The **ULV Biology senior exit survey** (Appendix J) indicated very strong support for the statement that the faculty prepared them well for understanding the 'discovery process in science'; however problem solving skills and ability to analyze problems and data were supported less strongly. Of particular concern was the ambivalent support offered for the statement 'science seminars contributed positively to (the) learning process.

Juniors and Senior-level biology majors are required to attend weekly seminars their final four semesters. Science seminar offers regular exposure to the presentation of research from invited speakers, faculty and fellow students. These seminars cover a wide range of scientific topics (including chemistry, physics, and astronomy, as well as biology). In addition to being expected to listen carefully and interpret results, seminar students are encouraged to ask speakers questions about their research and are required to write an evaluation of the speaker. The goal is to expose students to the scientific process from many different perspectives. However, students in the senior exit survey reported rather weak agreement with the statement that 'science seminars contributed positively to your learning process' (**Science seminar analysis**, Appendix F).

Junior and senior biology students (as well as those of other science majors) are required to present a synopsis of a research paper (junior year) and the final report on their senior project at the weekly science seminar. Ideally, students select and read an article relevant to their chosen senior project. Senior project mentors facilitate this activity by reading the paper as well and discussing the findings with the student. Mentors also help prepare the student for the oral presentation. Following the peer seminar presentations students are required to evaluate the presentation to provide feedback to the peer presenter and to hone their skills in critiquing ongoing research.

Students would benefit from mentors, faculty, and students taking the junior presentation more seriously. Often students fail to contact their senior project mentors about the junior presentation, or do so at the last minute. Faculty have discussed enforcing consequences for students who do not fulfill this requirement. Potential consequences could be doing the exercise over or having the student retake the seminar course.

Biology focus group students (Appendix G) noted that the laboratory curriculum of the biology program was a significant strength, as was the opportunity for outside the scheduled classroom laboratory access.

In summary, considerable effort is currently being expended by the faculty to expose students to the primary literature, but additional attention is warranted in oversight of preparation of the initial section of the senior thesis. Further, it appears that for many students, a two hour research methods and biostatistics course offers insufficient training in methodology and data analysis. Finally, the weekly science seminar is designed to introduce students to the process of preparation and presentation of oral scientific papers, but is viewed by students to be of marginal value. Improving the seminar experience will warrant some attention.

D. **Learning outcome: Biology majors will be able to design, implement, analyze data and prepare a formal report on the results of an independent research project or culminating senior experience.**

Currently all biology majors are required to complete a 'senior exercise' that typically requires planning, implementation, analysis and formal write-up of an individual research project. Historically, completion of the senior project has been problematic, and in 2000 a new course, Research Methods and Biostatistics was implemented to facilitate timely completion of the senior project. In spite of this course addition and also focused department level attention, low completion of the senior project continues to be a concern. Dr. Wright's **senior thesis evaluation** (Appendix D) offers some insights into improving both the quality and success of the senior theses. In his analysis, Dr. Wright noted that although some of the projects were 'very good under Pomona College standards, and as good as I have seen anywhere', the quality was determined to be quite variable. The following specific areas were proposed in his analysis as areas warranting improvement:

1. Abstracts in general fell short of providing a synopsis of the entire study.
2. While many theses did a 'commendable job of reviewing the general research area', and 'most were well written', two general deficiencies were offered:
    a. The depth and extent of the primary literature review could be improved
    b. The derivation, articulation, and stated rationale for the research question could be better addressed
3. A recurrent shortcoming of the Materials and Methods sections was limited guidance for the reader concerning (i) 'how/why a particular methodology provides an appropriate test of the question, and (ii) how treatment groups and control groups were differentiated and the numbers of replicate studies determined in each case.
4. The primary shortcoming identified in the Results section concerned data presentations and analysis. This deficiency is of concern because the course BIO 379, Research Methods and Biostatistics was implemented specifically to address this perceived deficiency. Adequate coverage of research methods and statistics in a two credit hour format is probably over-optimistic and implementation of a more comprehensive course in biostatistics should be considered.
5. The Discussion sections were judged to be weakest in including a comparative review of the literature and of posing further questions/directions for future work.
6. Finally, the Bibliography/literature cited section often placed too great a dependence on just a few key sources.

Students that are unable or unwilling to conduct an empirical project may opt to write a review paper, although this option has been generally discouraged. Two non-empirical senior projects evaluated by Dr. Wright were deemed to be 'weak'. His major recommendation was that we consider formalizing a non-experimental opportunity for students and suggested consideration of a 'grant proposal' option similar to that utilized by Pomona College.

Finally, in a 'collective summary and recommendations' the following key points were made concerning perceived areas of weakness in the experimental papers:

1. Setting clear expectations for all 'theses' to include statistical analysis

2. Requiring greater emphasis in citing original research papers.
3. Providing students with a more detailed and explicit set of thesis guidelines.

In spite of the deficiencies noted for many of the senior theses, in recent years they have undergone improvement and greater attention and expectations are being made. Since 2000 a significant number of student research projects have led to formal presentations at regional and national scientific meetings (Appendix P).

Senior project students are encouraged to present the results of their projects at regional and national conferences such as the Southern California Academy of Science. In the 2003-2004 academic year three students presented papers, one of which (Thomas Hatch, The Effects of Excess Zinc on Developing Murine Thymocytes) received recognition as the top student poster presented in the area of molecular biology. Examples of recent publications and presentations by students are contained in Appendix P, **Examples of professional papers given by students and faculty**, which also contains a complete listing of biology senor projects completed during the 2000-05 academic years.

Biology seniors (n = 8) polled during Spring 2005 (**Biology senior exit survey**, Appendix J) had mixed responses regarding self-assessment of their preparation for analyzing problems/data, and also in conducting research and problem solving. For some, the experience was rated very highly while for others it was a source of frustration and stress. Further, there was rather weak support for the statement 'science seminars contributed positively to the learning process'. It seems that both the structure and format of the weekly seminar, and also the senior project experience warrant review and revision.

Positive responses (on a scale of 1-4 with 4 being 'strongly agree') on the **Alumni survey** (Appendix M) concerning research skills and the research experience show that alumni felt that 'ULV offers a high quality program' (mean = 3.48), that the 'discovery process of science is well understood' (mean = 3.28), and that their ULV 'research was a positive learning experience' (mean = 3.43). Less strong agreement was reported for 'preparation for analyzing problems and data' (mean = 2.85), and 'preparation for conducting research and problem solve' (mean = 2.93).

Many students struggle with the senior project and a substantial number fail to finish their project on time. Many take an additional year to finish and a significant number fail to finish at all. Several stakeholder comments (**SWOT analysis**, Appendix E**)** emphasized this issue, suggesting that the student research process 'lacked structure/sustained oversight', and suggested an 'alternative to the empirical project' now emphasized. It does seem apparent that both an alternative project option and better tracking of students in their progress toward project completion the project are warranted. Coupled with this issue are an increase in student numbers and a decline in departmental faculty number, each of which operates to increase the burden of faculty oversight.

One additional positive comment made by stakeholders concerned a recognition of the valuable opportunity of students to conduct research with faculty.

In summary, research opportunities are seen as having value and important to the educational process, but success in timely completion of the senior project is unacceptably low. In addition to improvement of the quality of the projects, it is recommended that an alternative to the empirical thesis be considered and that students are more closely tracked in the progression of their project work.

E. Learning outcome: Biology students will show competency in divergent areas of the biological sciences, including molecular/cellular, organismal, evolutionary and environmental sub-disciplines.

During the interval 2000-2004, 76% (N = 58) of seniors received a passing score of 50%+ on the **senior examination** (Appendix H) in the initial taking. Of the 13 who failed the exam on the initial try 77% (10) passed on the second try. Of the remaining three, one passed the third test and the other two left school without their degree.

In 2005, following exam revision, the pass rate rose to 85% (n = 7). Because of the revision, data from this year was separated from that from the previous 5 years. Senior exams administered between 2000 – 2004 consisted of 139 questions addressing ten major area sub-disciplines (cellular, biochemistry, molecular, developmental, genetics, ecology, evolution, anatomy/physiology, zoology, and botany). The question distribution on examination however was found to be uneven, ranging from 3-18% per topic area. The 2005 exam was restructured for a more equitable balance yielding numbers of questions/topic area ranging from 6-15%. Obviously, some questions could fall into more than one category, but the revised exam is considered to be a more appropriate reflection of coursework taken by students, and the high pass rate of 2005 could be a reflection of this adjustment. A copy of the 2005-revised exam in contained in the Appendix H, as are charts summarizing the revised subject area distributions of questions.

When BIOL course listings are correlated with **subject matter understanding and skills in the general sciences and biology curriculum** (Appendix K), it is evident that each sub-discipline is represented by at least two courses, and in many cases students may take three or four courses per area. The main exception to this general rule would be students who major in Environmental Biology having minimal or no exposure to molecular/cellular at the upper division level. They of course receive a comprehensive introduction in the BIOL 203, 204, 205 sequence.

In summary, evidence from both analysis of **subject matter understanding and skills in general science and biology**, and performance on the **senior exam** support adequate achievement of competency in the various sub-disciplines of biology.

F. Learning outcome: Biology will receive good program and career related advising

Faculty, staff, and administrator's (**ULV stakeholder SWOT interviews**, Appendix E**)** have a positive perception of the Biology program and identify Biology faculty as being available,

caring, and nurturing in their students development both as scientists and adults. The Biology department is seen as a cohesive group that collaborates well with other departments, thus optimizing student experiences in both the classroom and research (or field) laboratory. The curriculum is a balance between cellular, organismal, and environmental sub-disciplines. It is demanding, but such rigor is deemed essential in preparing students for advanced degrees and professional schools. Students are also expected to do "hands on" research using state of the art high tech equipment, typically obtained by faculty efforts and grants, or through collaborations with other institutions (e.g. Western University of Health Science and University of Southern California). A solid curriculum coupled with research provides balance between theoretical and practical biology. It is through these experiences and interactions with faculty that guide students in decisions regarding their program or career.

In the **Senior Biology focus group survey** (Appendix G); biology seniors reported that one of the strengths of the Biology program was encouragement to attend graduate and professional schools.

A response percentage of 30 (n = 40) was obtained for the **alumni survey** (Appendix M) and confirmed many of the perceptions of stakeholders. Alumni agreed strongly that the Biology faculty actively engaged in learning and demonstrated a strong knowledge base. A post-baccalaureate degree was pursued by 70% of the alumni. Of these, five obtained certification training (certificate) or another bachelor's degree, 14 received a master's degree, and nine earned a doctoral degree. One of the questions within the alumni survey was: 'Are you currently employed in a job related to your major?' Seventy percent of the respondents answered yes; while 65% of those surveyed stated they found a job within 1 year of graduation (this percentage includes jobs as well as graduate school attendees). Seven percent obtained a job within 2 years and 28% were unable to find a job of their choosing. The 30%, who did not have a job related to biology, typically were part of the 28% who did not find employment within 2 years, suggesting that their unemployment was not due to a lack of training or preparation.

Alumni regularly return to ULV and express their appreciation for the professors in aiding their maturation as adults and preparation as professionals. Below are a few excerpts from recently received emails/letters (see '**Unsolicited letters received from biology graduates,** Appendix R**)** that echo themes stated in the stakeholder interviews and the alumni survey:

> "I have been accepted to Western Medical School and will be starting in August of 2004. … My research this summer was incredible experience and my time in lab at La Verne provided me with invaluable skills. I can't tell you all how much I appreciate all that you have done for me but thank you for your help with my application and my education" – Amanda Holthouse, 2003.
>
> "I was amazed that the education and training I received at ULV really prepared me for what I'm going through now at dental school (University of California: San Francisco). Most people usually say that dental school is really tough, but I seem to think its going fine and I'm actually enjoying it…" Danny Ramirez, 2004.

> "I started my second year of pharmacy school (University of California: San Diego)…it overlaps with first year medical students, so essentially I am going to medical school this year…. If anyone wants to know what "medical school" is like the first year, tell them … its like taking Biochemistry, Cell Biology, Developmental Biology, Anatomy, and Physiology (ULV versions) all at the same time. It's very busy, but much of the background knowledge is already in place, so its actually manageable with some careful planning" Tom Hatch, 2004.

In summary, students, alumni, and stakeholders offer agreement with the statement that the biology departments prepares and advises students well for professional schools and careers upon leaving ULV.

G. **Learning outcome: Biology students will matriculate into graduate programs and/or obtain employment in a biologically related field if so chosen.**

An integral part of student preparation for careers in the biological sciences requires training in the discovery process of science, development of problem solving skills and the ability to analyze data. In addition, students' need to take with them, into the work force, or graduate school, a clear understanding of the role that science and technology plays in our society. A component of the **senior exit survey** (Appendix J) was dedicated to these specific competency goals. As shown below, students' ratings (on a scale of 1-4, 4 being the highest) indicated that they were well prepared.

How well did Biology Department faculty prepare you…

1. in understanding the discovery process of science?	3.750
2. to analyze problems/data?	3.375
3. to do research and problem solve?	3.125
4. in understanding the role science and technology play in society?	3.375

Below are additional data that show that ULV biology students enter with average critical thinking abilities, but significantly improve their skills by the time they are seniors. In fact, senior biology majors scored higher than any other major tested at ULV (scoring in the 76th percentile, when compared to a national sample), although these results should be accepted with caution because of small sample sizes.

Table 1. Critical thinking scores of ULV students. From "Summary of 2004 Results from CAAP (collegiate assessment of academic proficiency)", prepared by A. Der-Karabetian

	Freshman		Seniors	
Major	N (freshman)	Percentile rank (national) freshman	N (seniors)	Percentile rank (national) seniors
Biology	6	**44**	7	**76**
Business	8	44	25	50
Communications	5	50	7	69
Comp and Info Sci	-	-	6	22
Social Science	10	44	7	64

Biology department faculty have made efforts to keep in contact with former students, and, as a result, have information regarding acceptance to graduate schools and success in obtaining biology-related positions. The following table reflects the types of positions and further graduate training procured by our students in the past five years.

Table 2. Numbers of ULV biology graduates accepted into professional schools during the interval 2000-2004.

Environmental Biology position	Veterinary and medical school	Medical technology and nursing	Teaching	Pharmacy and dental school	Graduate school (Masters and Ph.D. programs)
5	3	5	5	3	4

Generalized exam scores for medical, dental, pharmacy and graduate school admission also offer some indication of how well students are prepared. Unfortunately, students are now not required to report their scores. Thus, reporting has become less frequent than in the past, and we were only able to find a few (~5) current scores from 2000-2002, but the remainder date from 1998-1995. Of concern, the percentile ranks are very low, and it isn't known if this is small sample size anomaly, or whether it indicates that students over this time interval left ULV poorly prepared. A summary of the data is found below:

Table 3. Exam scores for medical, dental, pharmacy and graduate school admissions. (Note: Writing sample scores are reported as a letter, J through T. These scores were converted to numerical values in order to report a mean and standard deviation. To make this conversion J, K, L, M, N, O, P, Q, R, S, T, were replaced by numbers 1-11, respectively).

Test Section	N	min	max	mean	Std dev.	Approx. percentile rank range
Verbal reasoning	29	2	11	5.103	2.425	11-18%
Physical Science	29	3	10	6.345	1.778	20-34%
Writing sample	29	2	11	5.414	2.542	35-46%
Biological science	29	2	10	6.414	2.307	18-28%

Summary: Student exit survey information and data from the 2004 CAAP report indicate that students are well equipped with the necessary skills for success in a biological science-related career or to enter graduate school. Although the MCAT scores available from recent years are low, the small sample size and success of recent students in entry into medical school suggest this is an anomaly, but warrants further data gathering and analysis. A better indication might be the numbers now attending graduate school (Table 2) and the positive comments reflected in their letters to faculty attesting to their perceptions of their preparation.

VII. Recommendations for action

1. Consider revision of the Environmental Management major into an interdisciplinary environmental studies major

2. Refocus green campus efforts by involving students in campus projects.

3. Consider expanding the research methods and biostatistics course into a 3-4 hour course to better cover biostatistics or possibly require students to take a statistics course offered by another department, such as Psychology.

4. Consider the implementation of alternatives to the empirical senior project now emphasized for meeting graduation requirements.

5. Develop a better tracking strategy to monitor progress of senior projects and minimize the chances of students losing the momentum begun in the fall semester of their junior year.

6. Consider adjustment of the teaching load expectations of faculty engaged in research and oversight of student research projects beyond a given number.

7. Rethink/revitalize the science seminar format and make appropriate adjustments.

8. Apparently low MCAT scores in recent years suggest that there may be a problem with preparation of students for matriculation into medical school and this issue warrants further analysis.

9. Consider revision of the biology curriculum, including identifying courses for possible deletion and courses for addition.

10. Cultivate additional adjunct faculty to aid in the offering of additional CORE 340 courses.

11. Revise syllabi to address perceived deficiencies as identified by Dr Wright of Pomona College.

12. Plan for pending retirements and staffing needs.

13. Explore ways to incorporate programming at the Montana Magpie Ranch campus into home campus programs.

14. Develop programs to recruit higher quality and better prepared students.

APPENDICES

APPENDIX A. Normal instructor teaching responsibilities (credit hrs in parentheses)

Christine Broussard:	BIOL 203 (4), BIOL 310 (3), BIOL 313 (4), BIOL 316 (4), BIOL 345 (2) CORE 340 (3)
Jeffery Burkhart	BIOL 205 (4), BIOL 325 (2), BIOL 326 (4), BIOL 327 (4), BIOL 378 (2), BIOL 379 (2), BIOL 390 (4), BIOL 499 (1-2), CORE 340 (3), GNST 100 (1).
Jerome Garcia	BIOL 203 (4), BIOL 343 (4), BIOL 344 (4), BIOL 346 (4), BIOL 376 (4), BIOL 441 (2), CORE 340 (3)
Harvey Good	BIOL 101 (4), BIOL 311 (3), BIOL 327 (4), BIOL 343 (4), CORE 340 (3) BIOL 335 (4), BIOL 344 (4)
Jay Jones	BIOL 314 (5), BIOL 379 (2), GNST 100 (1), BIOL 374 (4), CORE 340 (3),
Dan Merritt*	BIOL 313 (4), BIOL 322 (4) BIOL 326 (4), BIOL 328, BIOL 374, CORE 340 (3)
Robert Neher*	BIOL 101 (4), BIOL 312 (4)
Stacey Novak	BIOL 101 (4), BIOL 203 (4), BIOL 204 (4), BIOL 302 (4), BIOL 311 (3), BIOL 316 (4), CORE 340 (3)

* Half-time teaching during 2004-05

Adjuncts

Randy Good	BIOL 101 (4)
Fredda Fox	BIOL 101 (4), BIOL 334 (4) + (other CAPA courses)
Jose Bava	BIOL 101 (4)
Yolly Aquino	BIOL 101 (4), BIOL 203L (1)

APPENDIX B: Recent course enrollments*

	2001-02	2002-03	2003-04	2004-05	
BIOL 101	303	290	258	309	
BIOL 203	44	50	42	64	
BIOL 204	32	27	30	40	
BIOL 205	15	14	19	20	
BIOL 302	3	16	-	16	
BIOL 310	16	11	7	12	
BIOL 311	22	18	13	19	
BIOL 312	23	16	16	12	
BIOL 313	13	10	12	15	
BIOL 314	14	10	15	16	
BIOL 315	-	-	-	0	
BIOL 316	4	7	4	-	
BIOL 322	-	5	-	4	
BIOL 325	-	-	-	2	
BIOL 326	-	-	5	-	
BIOL 327	5	1	1	1	
BIOL 334	11	14	15	14	
BIOL 343	41	26	57	55	
BIOL 344	17	10	17	24	
BIOL 345	7	7	-	-	
BIOL 346	7	7	-		
BIOL 374	-	-	15	10	
BIOL 376	7	5	5	-	
BIOL 378	9	16	12	24	
BIOL 379	15	10	10	17	
BIOL 390	15	-	-	11	
BIOL 441	-	-	-	20	
BIOL 499	19	19	18	21	*Mean class size = 17.3