Program Name: MS in Biological Sciences, Ecology, Evolution and Conservation

Use this cover page to provide the following information:

**Current unit requirements for program:**
The MS degree requires completion of 30 units of coursework with a minimum 3.0 GPA. The 30 units must include a minimum of 18 units of 200-level seminar courses.

**Listing of all required and elective courses for program (specify which):**

**Required Courses:**
- (2 units) BIO 220. Introduction to Scientific Inquiry. **Units:** 2.0
- (2 units) BIO 294B. Seminar in Ecology, Evolution and Conservation. **Units:** 1.0
- (2 units) BIO 221B Methods in Ecology, Evolution, and Conservation. **Units:** 2.0
- (3 units) BIO 282. Evolution. **Units:** 3.0
- (6 units) BIO 299. Problems in Biological Sciences.
- (4 units) BIO 500. Master’s Thesis. **Units:** 4.0

(11 units) of approved elective course work in Biological Sciences. Note: two additional units of BIO 294 A/B can be taken. No more than 6 total 299 units can be counted towards 30 units. Elective courses may be chosen from the following:

- BIO 222. Molecular Biology. **Units:** 3.0
- BIO 223. Human Molecular Genetics. **Units:** 3.0
- BIO 224. Genomics, Proteomics, and Bioinformatics. Student. **Units:** 3.0
- BIO 225. Stem Cell Biology and Manufacturing Practices. **Units:** 1.0
- BIO 245. Host/Pathogen Interactions. **Units:** 3.0
- BIO 247. Contemporary Topics in Immunology. **Units:** 2.0
- BIO 260. Advanced Ecology. **Units:** 3.0
- BIO 269. Behavioral Ecology. **Units:** 3.0
- BIO 273. Advanced Fishery Biology and Management. **Units:** 3.0
- BIO 279. Conservation Biology and Wildlife Management. **Units:** 3.0
- BIO 282. Evolution. **Units:** 3.0
- BIO 283. Biogeography. **Units:** 3.0
- BIO 285. Topics in Biology. **Units:** 3.0
- BIO 293. Research Conference. **Units:** 2.0
- BIO 297A. Teaching Biology Seminar. **Units:** 1.0
- BIO 297B. Laboratory Teaching. **Units:** 1.0

Most graduate courses are taught once per year or once every other year. With approval from their advisory Committee, students may choose electives from a select number of 100-level courses.
Criterion 1: Quality of Curriculum, Instructional Personnel, and Curriculum Delivery

Upon re-reading our original submission, clearly we did not properly indicate the origins and status of the MS in Biological Sciences, Ecology, Evolution and Conservation. This is a brand new program. It evolved out of the former MS in Biological Sciences, Biological Conservation program. The switch to the new program occurred only this semester and as a result it is somewhat challenging to provide some of the information that was requested. For example, we have no graduates yet, though we expect some very soon. In fact, the university computer system does not yet allow students to automatically apply to this program – we must manually adjust their admission status.

Why a new program? The older program (Biological Conservation) served us well for many years; however, biology is evolving rapidly and over the last several years we have noticed a gradual shift in our student population. The original program had a clearly defined goal: to train personnel to go into jobs in the local, state or national resource-based agencies, e.g., Cal Fish & Game, US Fish and Wildlife. As such, the program focused on training this student population. While we still have that goal for our students, many are increasingly interested in continuing their education after the Masters. Also, the field is changing so rapidly that specific knowledge has a short half-life. Therefore, we felt it necessary to continue to provide some discipline-specific knowledge and skills (e.g., training in Advanced Fisheries) but also to emphasize concept-based learning such that the student could understand principles and implement the scientific method at an advanced level. This makes our graduates more able to adapt to the ever-changing research and employment landscape. Ecology, Evolution and Conservation biology do not have a narrowly-defined set of tools, rather, practitioners learn and use whatever technology or skills are appropriate for answering the question at hand. These might be standard field methodology skills such as proper sampling techniques, but they might also be molecular techniques for population genetics analysis, GIS techniques for spatially-oriented data, bioinformatics tools for determining the evolutionary relationships of organisms, or sophisticated modeling techniques available through Mathematica to understand population interactions.

While we expose the students to many different tools in courses like Bio 221B, the emphasis is not on learning that particular tool, but rather on engendering the attitude that the student should feel empowered to learn and utilize whatever tool or technique is necessary to test their ecological or evolutionary hypothesis. For example, this spring, each of the 19 students in Bio 260 produced a mathematical simulation model of an ecological process interesting to them, something none had done before. These will be posted online at the end of the semester.
Section: Clearly Developed Learning Outcomes

Criterion 2: Clearly Developed Learning Outcomes

The Department of Biological Sciences has recently adopted a series of Graduate Student Learning Outcomes for all graduate programs in the Department. These are found on the Departmental website http://www.csus.edu/bios/GradProgramOverview.html. They are: 1. Students will demonstrate critical thinking through their ability to effectively search the scientific literature; read, understand and critically evaluate that literature; and draw appropriate conclusions from that literature. 2. Students will demonstrate acquisition of discipline-specific knowledge. 3. Students will be able to design original experiments, or conduct observations, with appropriate controls that test alternative hypotheses. 4. Students will be able to collect experimental data using appropriate theoretical, laboratory or field techniques and/or instrumentation. 5. Students will be able to analyze and evaluate scientific data using appropriate statistical and other analytical tools (e.g., phylogenetic, bioinformatic, and/or mathematical software). 6. Students will be able to communicate science and particularly their own scientific discoveries through a variety of media, including oral communication (e.g., presentations, seminars), visual communication (e.g., graphs, figures, posters) and written communication (e.g., research papers, final thesis, grant proposal or project, as appropriate for their concentration).

Individual graduate programs further emphasize particular aspects of these and implement and assess these in different ways. EEC is a new graduate program as of this spring and the major emphasis in EEC is on strong experimental design and hypothesis testing.

Key characteristics of the program ensure student success at achieving these goals, starting when the student applies. A student is not admitted into the program without the written approval of a faculty mentor who agrees to supervise the student throughout their degree. Each student is further guided by an individualized supervisory committee of three (or more) faculty. These committees may employ faculty from other departments or outside the university if the particular research would benefit from that expertise (recent examples include Rob Titus of Cal. Fish & Game for fisheries knowledge, Miles Roberts of the CSUS Geography department for GIS technology and techniques).

Student learning outcomes are discussed between the student, faculty mentor and supervisory committee, and are particularly prevalent in the required coursework. For example, all students must take Introduction to Scientific Inquiry (Bio 220) in their first semester to ensure that they can critically evaluate scientific literature and develop testable hypotheses. Students then take Methods in Ecology, Evolution and Conservation (Bio 221B) to learn discipline-specific techniques in ecological and evolutionary experimental design, use of technology (such as Mathematica, molecular tools), data-sampling strategies (via field work), and data analysis (SPSS, SigmaPlot) to test hypotheses. This course is currently team-taught by four professors to maximize student exposure to a broad range of approaches and techniques. Students must take Bio 294 twice to further develop skill at critical thinking and literature analysis and 6 units of Bio 299 to focus on their individual research. Additional courses (e.g., Behavioral Ecology) allow the student to further refine their knowledge and acumen for designing and evaluating experiments, and analyzing data. Throughout, there is a strong emphasis on communication, through writing term papers, construction of visual materials (e.g., posters in Bio 260), and oral presentations in most courses.

The student’s ability to Master these skills is formally assessed at the Advancement to Candidacy meeting where the student is required to give an oral presentation of their intended research. They must show understanding of the pertinent scientific literature and the development of a testable hypothesis, along with preliminary data showing that they have mastered the techniques necessary to acquire the data (discipline-specific knowledge) to test that hypothesis. A written abstract of this presentation serves as a formal agreement between the student and the Department of what is to be accomplished before graduation.

Finally, the student is required to prepare a written thesis, which must be approved by the supervisory committee and the graduate coordinator. The student must also present an oral thesis seminar, open to the public, in which they demonstrate their ability to understand and communicate the key points of their research and to answer questions about that research. The presentation must be approved by the supervisory and graduate committees.
Criterion 3: Advising Program and Graduation Success

As stated, but perhaps not emphasized enough, the MS in Biological Sciences, Ecology, Evolution and Conservation is a brand new program. As such, we could not contextualize the departmental graduation rate data, etc. for this program because no students have yet graduated from it; it first appeared in the Catalog earlier this year.
Criterion 4: Strength of Teaching Performance

Faculty are not hired specifically and exclusively for this program – faculty in the Department of Biological Sciences teach in many programs simultaneously -- so our original submission properly reflects our strength of teaching performance.
Section: Secondary Criteria

Criterion 5: Program History and Development Status
{add response here}

Criterion 6: Impact, Justification and Centrality to University Mission
add response here

Criterion 7: External Demand for the Program

We interpreted this criterion too narrowly in our original submission, limiting our discussion to demand from students while neglecting to mention demand for the faculty expertise associated with this program. The faculty involved in this program have extensive interactions and collaborations locally, nationally and internationally.

Community Engagement:
Faculty members in the Ecology Evolution and Conservation areas volunteer their time and expertise to local organizations involved with environmental preservation and education, such as the Sacramento Valley Conservancy, the Middle Mountain Foundation, Yolo Natural Heritage Program Steering Committee, American River Natural History Association and Hima Mesopotamia. Ecology Evolution and Conservation faculty contribute to many extracurricular educational activities such as being advisors and judges for school science fairs, Academic Talent Search, a coach for the California Department of Fish and Game Nature Bowl (an environmental education event), Dinner with a Scientist events at UC Merced, Stockton and Sacramento, Expanding Your Horizon event for grade 6 girls, and a research project director for Earthwatch Institute. One faculty member serves as an advisor to Capital Public Radio’s Environmental-Energy News Reporter and another is on the Board of Trustees of the American Cichlid Association. We serve as faculty advisors to student clubs such as the Field Biology Club and the Pre-Vet Club, and provide academic advising to non-CSUS students. Among the most significant efforts in community engagement is Dr. Baxter’s California Environmental Legacy Project (http://www.calegacy.org/), an NSF-funded, statewide educational media initiative aimed at enhancing the quality of science education for public audiences.

Demand for the Program’s Resources and Expertise:

Our faculty lead workshops for area science teachers to help them better teach challenging concepts like evolution. Laboratories, technical staff, and faculty in Ecology Evolution and Conservation, provide resources for faculty and student research (both from within CSUS and from other institutions), public education and public services. The following resources are under supervision of Ecology Evolution and Conservation faculty and staff: CSUS Museum of Natural History, Museum of Ectothermic Vertebrates, University Arboretum, Greenhouses, Insect Collection, Herbarium, CSUS Bioinventory, CREST (the Center for Regional Environmental Science and Technology).

As professional scientists, our faculty have served as members of NSF Grant panels, editorial boards, reviewed dozens of journal articles, reviewed grants for 9 organizations and foundations, and reviewed books and/or book chapters for 9 publishers in the field of ecology, evolution, behavior and general biology. We have been invited to speak both nationally and internationally at conferences, workshops, symposia, university seminars (ranging from UC Davis and UC Merced to Moss Landing, University of Colorado, Rutgers, Costa Rica). We have collaborators locally (UC Merced, UC Davis) nationally (Rockefeller University, Colorado University, Illinois State University, University of Southern Mississippi, University of Florida, Rutgers) and in other countries (Imperial College, CSIRO, Costa Rica).
Section: Secondary Criteria

Criterion 8: Program Size, Scope
{add narrative here}

Criterion 9: Internal, Non-major Demand for the Program
{add narrative here}

Criterion 10: Quality of Program and Resource Utilization
{add narrative here}

Criterion 11: Revenue and Other Resources Generated by Program
{add narrative here}

Criterion 12: Costs and Other Expenses of Program
{add narrative here}