Focus on Undergraduate Curriculum and Student Experience:
Department of Geosciences, Fall 2015
Geology and Earth Systems majors

Report by the Geology/Earth Systems Curriculum Committee, Nov. 20, 2015:
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During the Fall 2015 Semester, Department Heads and Curriculum Committees were asked to conduct a review and analysis of their undergraduate curriculum. The Geology and Earth Systems majors convened a combined Undergraduate Curriculum Committee to conduct this review. This report describes the results from this review and analysis, meeting the Provost's requests for (1) an analysis of the current curriculum; (2) goals for student learning and the student experience; and (3) a curricular revision action plan. This report does not include a synthesis of our joint major in Environmental Sciences with the Dept. of Environmental Conservation. Rather, given the development of the School of Earth and Sustainability through the UMass Governance Process, full assessment of the Environmental Science major by both departments with the School of Agriculture will require more inquiry, but not within the timeframe of this request.

Please note that the Department of Geosciences at UMass Amherst offers three distinct undergraduate programs: Earth Systems, Geography and Geology. Each of these programs offers a B.S. degree, and the Geography and Geology programs offer a B.A. degree; the majority of Geology majors receive a B.S. while the majority of Geography majors receive a B.A. degree. Additionally, the Department of Geosciences shares organization and management of the Environmental Science undergraduate degree program with the Department of Environmental Conservation and the Stockbridge School of Agriculture. This report reviews and analyzes curriculum within the Geology, Earth Systems and Geography undergraduate programs; the Environmental Science undergraduate program is discussed in a separate report. The Environmental Science curriculum review was not provided to Geosciences in time for a thorough assessment, but the Geosciences curriculum committee will analyze and contribute to the Environmental Science curriculum report in the coming months

Summary Statement

The Geology and Earth Systems undergraduate programs provide students with a highly effective and accessible curriculum that comprises courses, advising and departmental opportunities for participation in research and career preparation. Our faculty's efforts in teaching and advising are very highly rated by students, in many regards highest among CNS departments and across the UMass campus. We face challenges in finding the appropriate use of tenure-stream versus non-tenure instructor resources in the effective teaching of our lower-division courses, as well as in expanding the programmatic breadth and student body diversity among our undergraduate majors. None of these challenges is insurmountable, and we are confident that specific actions identified in this report will yield positive benefits for students and faculty.

Response 1. Analysis of Current Curriculum: Earth Systems and Geology
The Geology and Earth Systems majors are valued by students for the coherence and accessibility of our curriculum, the mentoring and advising that faculty provide to our majors, and the students' ability to interact with faculty in small courses, individualized research experiences, and in an integrative capstone courses.

1a. Coherence and Accessibility of Essential Curricular Features

Geology Major The Geology major includes a sequence of required courses, including supporting sciences, and electives. There are two formal subplans in the Geology B.S. major: the geology track and the earth science track. The Geology B.S. – geology track is the most commonly subscribed track, with a sequence of eight required Geosciences courses, six required supporting science courses, 12 required credits of upper-level Geosciences electives, plus the required JYW and Integrative Experience courses. The Geology B.S- earth science track is pursued by several students each year, primarily those who intend a career as secondary teachers in earth science; this track features fewer core geology courses compared to the geology track, but includes additional astronomy and planetary geology courses required for licensure. The Geology B.A. major provides a highly flexible curriculum of three core Geosciences courses, 21 credits of Geosciences electives and supporting science courses chosen from any CNS department; the B.A. is chosen by a small number of students either pursuing a dual major in concert with another B.A. degree, or by students who value a highly flexible geology major. The curriculum for each major and track has been tried, tested, and refined over many years to provide an accessible and workable course sequence, leaving ample room for electives. Students from each track and major in the geology program are strongly encouraged to fulfill a portion of their electives credits as junior- or senior-year independent studies and/or senior research project; approximately 54% of our majors conduct a research project with a faculty member, which is well above the UMass mean of 32%. Model semester-by-semester course sequences are available on the department website for each of the geoscience majors. The choice of General Education courses is left to the students and key Gen-Ed courses are not identified except for supporting science courses (MATH, CHEM, PHYSICS) that are required for the major.

Earth Systems Major The Earth Systems major was established for students wishing a broader geoscience curriculum that involves a holistic understanding of the Earth's geosphere, biosphere, hydrosphere, and cryosphere, as well as the impact of human activities on these systems. As such, this major's curriculum offers a highly flexible blend of geology, geography, social science, and planning focused around geoscience issues. However, with the recent revisioning of the Environmental Science major (shared between Geoscience, Environmental Conservation and the Stockbridge School) the number of students pursuing an Earth Systems major has declined, and the unique niche of the Earth Systems curriculum has eroded. Moreover, while the term "Earth Systems" resonates very strongly with faculty and researchers in the Geosciences both at UMass and at many institutions across the country, the focus of this term is less clear to 21st-century undergraduates who are perhaps more familiar with concepts of environmental sciences and sustainability. As such, the Department of Geosciences plans to suspend this major following this curriculum review.

Courses for the Geology and Earth Systems majors benefit from both high coherence and high accessibility. Our course sequences are logical and cumulative. While some courses reach capacity, instructors are typically generous with overrides, and our majors do not suffer the problems common in other majors in which required courses simply are not readily available (we hold the 3rd highest rating of accessibility among CNS majors in the 2014 NSSE). Our curriculum balances core and required courses with ample flexibility in the form of electives (approximately 1/4 of required Geosciences as elective credits in the most common Geology B.S. track). Many students complete their electives by taking 500-level courses (600-level with instructor permission) together with our graduate students. This benefits our undergraduate majors in the form of small class size and a high bar for success. However, the high reliance on graduate-level courses to fulfill our students' electives credits has some negative consequences. Among these are more intermittent scheduling of such courses (once every four to six semesters, in some cases) and a focus on specialized topics that emphasize academic research and limit preparation in non-academic career skills.

One aspect of the Geology and Earth Systems majors not found in many other sciences is that students generally do not "discover" geology as a field of study until they have completed one or more semesters at the University. **Few high schools offer modern geosciences courses, and in Massachusetts, geology or earth science are not taught in the majority of schools because this material is not on the Massachusetts Comprehensive Assessment System (MCAS) tests used for measuring student competency for graduation.** Thus, student exposure to the discipline is extremely limited prior to college, and incoming college students may not be aware of topics within discipline nor of potential geosciences careers. Nationwide, the American Geosciences Institute reports that only 48% of geology majors selected their major in their first two years. At UMass, students often begin the major in their second or third year. This impacts the coherence and accessibility of our curriculum in that those students are working through the course sequence at quite different stages in their education and with different levels of background. This is a challenge for the faculty and also for the students, but one that our retention and student progress data suggest we meet quite well. At UMass, while relatively low numbers of applicants apply to UMass with an intention to be a Geology or Earth Systems major, our retention and time-to-degree for student once they declare the major are on par or higher than other CNS majors and for UMass overall.

1b. Clarity of communication

Student satisfaction with their interactions with faculty in the geology and earth systems programs is very high. Faculty engage students in conversations about long-term goals, including degree requirements, graduate school admission, summer internships, department research opportunities, and job seeking; these conversations commonly occur on an informal basis, with students seeking out faculty when questions arise. Office doors are commonly open, and students do not feel that they have to make an advance appointment to confer with a faculty member. Students rate their experiences in the Geology and Earth Systems majors very favorably; the 2014 NSSE found that our majors rated "quality of interactions with faculty" the ***2nd highest among all UMass major programs***! Students also report higher than the UMass-

wide mean on issues such as "satisfaction with academic advising in your major" and "faculty concern for academic progress". However, while access to faculty advisors is very strong and positive for our majors, there is some concern that faculty access in general could be improved; we were below the UMass mean for "accessibility of faculty in your major" in the 2014 NSSE survey.

Our students meet at least once a year with an undergrad advisor. Advising is distributed among several faculty, primarily the Chief Undergraduate Advisor [CUA] for the major and the Honors Program Director; many faculty do not actively participate in undergraduate advising for the Geology and Earth Systems majors, in part because many Geosciences faculty serve as academic advisors for students in the Environmental Science program. Currently, we do not require an advising appointment prior to pre-registration. However, to facilitate more regular and frequent advising, we plan to follow many other departments' approach and our own experience of 8-9 Geosciences faculty advising ~100 Environmental Science majors each year, and implement a registration hold (RAC code in Spire) that requires students to meet with their advisor in advance of preregistration each semester. This requirement would provide better oversight of the progress of individuals and improve the likelihood that problems be averted early in a student's program.

In the classroom setting, learning goals and course expectations are provided at the beginning of courses, along with syllabi. In fact, senior faculty heavily involved in undergraduate education strongly guide and encourage more junior faculty to explicitly incorporate learning goals and outcomes within their course syllabi, and in this they lead by example. A collection of learning goals for courses taught in the department has been compiled and is available internally on the department website. Students find the teaching effectiveness in our majors very high (consistently well above the UMass mean, and routinely the highest among CNS departments in overall "quality of teaching").

For many years, faculty members have conducted information sessions in the fall semester, focusing on 1) graduate school admissions, 2) internships and 3) job-seeking. These sessions are informal gatherings with a short presentation followed by questions, answers and discussions. All of our majors are on an e-mail list so that we can send blanket e-mails to them, announcing information sessions, upcoming talks, deadlines, and job opportunities. Nonetheless, communication of our curriculum, the opportunities it provides to students, and the careers it can lead to each could be improved. Students rate poorly our curriculum's efforts to help them acquire job- or work-related skills, and they identify "writing clearly and effectively", "speaking clearly and effectively", "thinking critically and analytically", "analyzing numerical and statistical information", and "solving complex real-world problems" as skills they would like better emphasized in our curriculum (2013 SRTI results). The solution to this is a curriculum-wide incorporation of these skills into courses across our curriculum.

We are also considering holding one 'class meeting' per semester for students in the first, second, third, and fourth year of the Geosciences major. At such a gathering, all of the majors who consider themselves to be second-year students, for example, would meet together, with

faculty, to discuss their progress through the program requirement as well as summer research and internship opportunities appropriate for their level, as well as regional meetings and events that would enhance their experience. These meetings would promote cohesion among class groups and provide benchmarks for progress through the program requirements.

1c. Effective use of faculty time

Class-size distributions in the Geosciences are highly bimodal. Our General Education introductory (100-level) class sizes are higher than most other CNS departments and those of most geology programs at other institutions, while our class sizes in upper-division courses are smaller than is typical across CNS or UMass in general. As a department, we teach more student credit hours and course sections per instructor than is done across CNS and UMass overall. Compared to other departments, more of that teaching is conducted by tenure-stream faculty and less by non-tenured instructors (i.e. lecturers and adjuncts).

Faculty in the Geology and Earth Systems programs feel stretched very thin between their research programs, their teaching and advising activities, and their other service responsibilities. Geosciences faculty teach more organized class sections and student credit hours than the average among other CNS departments, and this teaching is provided almost exclusively by tenure-stream faculty (97% of all student credit hours in 2013); this is among the highest amount of tenure-stream teaching across all CNS departments, higher than the UMass average and is much higher than found in Geosciences departments at peer institutions (average 55% across Delaware data institutions). We pride ourselves on our faculty's dedication to and involvement in undergraduate student teaching. However, this focus is not without its costs in teaching effectiveness (primarily large-enrollment introductory courses) and in other dimensions of faculty responsibilities such as research and service. Nonetheless, Geosciences faculty work very hard to allocate their time and resources in a way that provides students with an effective and engaging learning experience in the Geology and Earth Systems majors.

Providing meaningful advising and engaging all students in longer-term planning is a challenge; all undergraduate advising in the Geology and Earth Systems majors is conducted by tenure-stream faculty, with no additional staff or lecturers available to assist in this role. All of our students are strongly encouraged to talk to their academic advisors once or twice a year, typically during pre-registration. We have one Chief Undergraduate Advisor who serves both the Geology and Earth Systems majors; this faculty member also advises students interested in the Geology minor. We have one faculty advisor for the Geology and Earth System majors in the Commonwealth Honors College, who also assists with advising non-CHC students in the major. Because of the size of the Environmental Science major (nearly 300 majors), eight Geosciences faculty serve as academic advisors for this program. Although students rate the quality of advising they receive very highly, there are some concerns about career- and job-preparation. We must consider if our approach to advising, relying exclusively on a small number of tenure-stream faculty, is a best practice or if having advising staff could improve our students' experience as majors.

There is an important dichotomy in students' view of our teaching effectiveness between our large-enrollment, 100-level introductory courses and our upper-division courses. In short, our majors, and students in our upper-level courses in general, rate very highly the effectiveness of our undergraduate teaching, while students in our introductory courses present a more critical view. At present we offer 4 large-enrollment, 100-level introductory courses; each serves as a PS Gen-Ed course for non-majors as well as an entry course into our Geology and Earth System major. These are:

- GEOL 101 "The Earth": 120-140 students each semester in a single lecture section, with 6-7 lab sections each semester
- GEOL 103 "Introduction to Oceanography": 300 students each semester in a single lecture section, no lab/discussion sections
- GEOL 105 "Dynamic Earth": 250 students in a single lecture section, no lab/discussion sections, taught fall semester only
- GEOG 100 "Global Environmental Change": 180 students in a single lecture section, no lab/discussion sections, taught fall semester only

The large-enrollment courses serve simultaneously as introductory courses for our majors as well as Gen-Ed courses for non-majors. The four introductory courses we offer teach between 120-300 students each semester, taught as single-section lectures. Of these, only GEOL 101 has dedicated, small-enrollment lab sections. This is largely a legacy of insufficient TA allocation provided to Geosciences to support teaching of lower-enrollment discussion sections to complement the lectures in the other large-enrollment courses. We recognize that we could achieve much more effective student outcomes and engagement in these large-enrollment course with the opportunity for students to participate in discussion or lab sections, but until TA support is increased or we begin to offer senior geology majors the opportunity to lead discussion sections (as is done in some other CNS departments) this will not be possible.

As described above, most UMass undergraduates have very limited exposure to geology before college, and thus we rely on these introductory courses to recruit students to our majors. However, the pedagogical and management challenges of teaching such large lecture-only courses are severe, and low SRTI evaluations of those courses reflect these challenges. This compares unfavorably to other CNS departments in which 100-level, large-enrollment and Gen-Ed courses are taught by dedicated lecturers with reduced responsibilities in research and service, and for which sufficient TA allocation is provided to support small class-size lab and discussion sections that complement the main lecture. In order to improve teaching effectiveness for students in these 100-level courses, and to maintain or increase recruitment into our majors, we most on how best to gauge how (class size, restoring labs and/or discussion sections) and by whom (lecturers versus tenure-stream faculty) these courses are taught.

In stark contrast to the initial 100-level courses, upper-division classes in the geology and earth system major are small (all with less than 40 students, and most between 10-25 students). Students report that the quality and effectiveness of teaching in their upper-division courses is very high, rated among the highest across UMass majors. Students have good access to faculty in these small classes, as well as through our weekly seminar series and 5-College Geology

activities. We have two computer classrooms and a common room, which are regularly used by our undergrads, particularly after hours, when the students work together on projects and homework, or prepare for exams. The department is very collegial among undergraduates, grad students, and faculty. This greatly facilitates productive learning.

We do not require junior or senior research experiences, but the CUA for the Geology and Earth Systems majors and indeed all faculty strongly recommend a research experience for highly motivated students. 54% of our majors engage in a research experience with faculty before they graduate, and 78% pursue a field experience or internship; these percentages are well above the UMass average. Students are encouraged to approach faculty members about a potential research project; this is commonly sometimes facilitated by the CUA and the Honors Program Directory for Geology and Earth Systems,. Because our motivated students seek research experience, the establishment of the Commonwealth Honors College's departmental honors option, without requiring general honors studies, has been a popular option among our students. Our students also seek faculty guidance about grad school and career choices. Many of the Geosciences faculty serve as mentors for undergraduate research projects. We also make students aware of summer internship opportunities and strongly encourage our students to pursue these highly beneficial experiences.

The number and breadth of subfields in the geosciences have expanded greatly in recent years, especially with increased focus on global and regional climate change, water resources, mineral and hydrocarbon resources, environmental issues associated with resource extraction, natural hazards, extreme climatic events, etc. This is creating additional pressure for new required courses and new electives, which in turn, has put additional pressure on the faculty and the traditional curriculum. There is a sense that students need additional flexibility to pursue their interests. The Department of Geosciences Curriculum Committee is currently evaluating the balance between required courses and electives in light of the changing and expanding discipline and changing career options.

Response 2. Goals for Student Learning and the Student Experience

Our undergraduate learning goals were revisited and articulated in 2013, divided into department-wide goals and goals specific to the geology and earth systems major. The department-wide goals include:

- Critical thinking and analytic reasoning.
- Data analysis and interpretation skills.
- Real-world problem solving for effective decision-making.
- Working in groups and consideration of diverse perspectives.
- Effective writing, presentational, and computational skills.
- Professional and ethical behavior

Specific learning goals for the Geology and Earth Systems majors are:

- Fundamental geologic principles, including hands-on field experiences.
- Basic observational skills related to the recognition of rocks and minerals, common fossils and sedimentary environments, structures and tectonic features.
- Three-dimensional visualization of dynamic geologic systems.

- An understanding of geologic time and Earth history.
- An understanding of geologic processes and rates.
- Collection, integration, and analysis of data using a variety of tools and methods to solve real-world geologic problems.
- Use and critical evaluation of models to simulate and understand Earth processes.
- Solid background in physics, chemistry, and math.
- Access to interdisciplinary training in geochemistry, numerical methods, numerical analysis, and geophysics.
- History of the science and scientific method.
- New developments, techniques, and discoveries in the field.
- Application of geology to the challenges facing humankind, including natural resources, energy, water, geohazards, and global climate change

"Professional and ethical behavior" is becoming increasingly recognized as an important component of the toolkit of a professional geologist. We are exploring ways to weave discussion of professional ethics throughout our curriculum. These topics were addressed in part when we taught an in-house Junior Year Writing course, but since combining our majors JYW course with other departments as a CNS-wide course, professional ethics specific to the geology discipline has not been explicitly taught. Certainly, we can hope that professional ethics is demonstrated to our major through role models in the department (for example, many seniors taking electives courses with graduate students and participating in independent research experiences), but this is not an explicit part of our curriculum at the moment.

The Geology and Earth Systems learning goals are well-supported by our existing curriculum, and align well with peer institutions. Our faculty are active participants in national efforts at defining geoscience curriculum, and our learning goals mirror recent white-papers produced by the Earth Science Literacy Initiative (www.earthscienceliteracy.org) and the Summit on the Future of Undergraduate Geoscience Education (http://www.jsg.utexas.edu/events/files/Future_Undergrad_Geoscience_Summit_report.pdf).

Results from the SRTI and Senior Surveys largely indicate strengths in student perceptions of their major, but do suggest that students wish for improvements in:

- more/better career preparation
- writing preparation,
- job- or work-related knowledge and skills.

The American Geological Institute (AGI) provides survey data from faculty, students and employers across the geosciences. Recent AGI data indicate that faculty and employers nation-wide value a curriculum that provides the following:

- critical thinking and problem solving skills
- working in teams
- ability to access and integrate information from different sources
- continued ability to learn
- make inferences about earth systems from observations, experimentation and modeling

- solve problems that required 3D and 4D thinking
- work with uncertainty, ambiguity and incomplete information

Our Geology major curriculum addresses these goals.

The AGI data further indicate that while professionals rate the ability to "analyze geologic data such as maps, cross sections, logs and reports" very highly, faculty and students surveyed do not report extensive preparation in this. Professionals rate the ability to determine scales, rate, distances and other spatial/temporal data from imagery, surveys, maps, GIS data and report very highly, faculty and students report less preparation in this in their curriculum. Professionals also rate the ability to conduct investigations in the context of human health, safety and environmental regulations very highly, while students and faculty report less preparation in this in their curriculum. Professionals rate the ability to manage ground- and surface water resources, and to characterize hydrology properties of such systems, very highly, while students and professionals indicate less preparation in this. In contrast, faculty and students report strong preparation in interpreting sedimentary processes, structures, depositional environments and provenance as strong components of undergrad education, while geoscience professionals rate this competency less important. We are using these AGI survey results to help inform potential adaptations to our geology major curriculum.

Alignment of our curricular goals with diversity

We use the entering students in all Geosciences majors in 2013 as a snapshot sample of the evolving diversity of undergraduates in our Program. Entering Geosciences in 2013 the ratio of male/female students was 70/30, the ratio of white to underrepresented minority was 71/29, first-generation students comprised 10% of sample pool and 20% received Pell grants. These snapshot numbers from SRTI and Delaware Data reports are comparable to those of other departments across CNS and other geoscience programs in the USA. Because of the low numbers of reporting students, the percent of students reporting ALANA and the male:female ratio varies annually. Since 2004, the gender distribution of entering students has varied from a low of 17% females to a high of 63% with no significant trend through time. The department benefits from female graduate students and faculty role models who encourage, mentor and support female undergraduate majors both in formal instructional settings and informal settings. The racial and ethnic diversity of entering students has commonly been 0%, with the 2013 value of 29% being the highest the department has seen. In effort to increase the racial and ethnic diversity of Geology majors, the department annually offers a Bromery scholarship to minority undergraduate majors funded from generous donation of Randolph and Cecile Bromery. We have had a handful of applicants but have not yet had opportunity to award an undergraduate scholarship. Announcements of this scholarship are on our web page. More effort could be put into disseminating information about the scholarship to students within the Geoscience introductory courses who might be considering Geosciences as a major. We can also coordinate with the ALANA advising groups on campus to learn how we can both disseminate information about the Bromery scholarship and attract more students to the Geosciences majors. The low diversity among geology and earth systems majors is not unique to UMass, and UMass Geosciences faculty participate in ongoing national conversations about engagement and

increasing diversity in geosciences education (e.g. the Jackson School Summit) are seeking to address this. Nationally, the geosciences lag behind all other sciences in minority, low SES and first-generation student participation; reasons for this nation-wide observation are diverse and outside the scope of this report, but in part reflect student's lack of exposure to the discipline in high-school, lack of familial role models in geoscience careers, and lack of awareness of the many career options in the discipline that could provide meaning and value to these students' communities. Recruitment of students from minority groups, low-SES families and first-generation college students is both a goal and an opportunity for our department.

Alignment of our goals with internationalization

"Geoscience" by definition is global in scale and scope. Our courses push students to consider, quite literally, the whole Earth in their thinking and decision-making. Our curriculum includes the study of Earth processes that are spatially global or involve trans-world linkages. Furthermore, our courses deliberately integrate elements of the "human dimension" of the global environment, Earth processes, and environmental change. Many courses utilize global-thinking tools (e.g. GoogleEarth) to explore and understand integrated features of our natural world and our built environments. Our capstone IE course, framed around the cascading consequences of fossil fuel energy production, exemplifies the notion of local-to-national-to-global connectivity of Earth Processes, Energy Production, Environmental Policy, and Climate Change.

Geoscience faculty also engage our students in cutting edge solid earth, surficial processes and environmental research that includes field work and collaboration on every continent and from pole to pole. These international research connections and relationships with researchers at international Universities has contributed to an exceptionally diverse group of graduate students and post docs, which naturally enhances the exposure of our undergraduates to a broad range of cultural and scientific perspectives.

We also note that our faculty are known for their contributions to international education through participation in advanced summer graduate courses and REU programs in Iceland, Italy, Norway, and Svalbard, among others. Many of our faculty serve on international graduate examination committees and we also actively encourage our students to study abroad.

Response 3. Curricular Revision Action Plan

3a. Actions within existing resources

In the Geology and Earth Systems majors, we are fortunate to not observe systemic issues with our curricular sequence or access to courses. We also are fortunate the our class size goals closely match, if not exceed, those envisioned by the Provost; after 100-level introductory courses, our students enjoy classes with less than 40 students throughout the sequence of 200-, 300- and 400-level required courses. Elective courses (including 500-level grad courses) commonly have even higher faculty:student ratios.

Nonetheless, through review of the geology and earth systems majors curriculum we have identified several specific actions that could improve coherence of our curriculum, clarity of our communications and effective use of faculty time. Several actions can be accomplished within existing resources:

(1) Foremost of these is to implement required advising sessions with students identified as geology or earth systems majors. Commonly known as "RAC holds" or advising holds, these require students to meet with an undergraduate advisor who can then release the hold and allow students to register for the next semester's courses. We know that strong faculty advising is an excellent way to communicate and engage with students. In the past, the geology major has not forced this advising on students, but as opportunities for courses, research experiences and career guidance increase for our majors, we recognize the need to more effectively communicate these opportunities and expectations to students. Within our existing resources, we will instate advising holds for our identified majors effective for the Fall 2016 semester. As part of this change, we will distribute advising responsibilities among our faculty. The Chief Undergraduate Advisor and Honors Program Director will become advising coordinators for the major.

(2) A second step we can take within existing resources is to re-focus the prefix by which our courses are listed in the course catalog. For many years, the Department of Geosciences (comprising undergraduate programs in geography, geology and earth systems, and graduate programs in geography and geosciences) had a single course prefix for all courses: GEOSCI. This worked well for the geology and earth systems undergrad majors and for the geosciences graduate program, but was felt to negatively impact visibility of the geography program. Beginning in Fall 2014, undergraduate courses were separated into GEOG and GEOL prefixes to distinguish geography courses from other offerings. While well-intentioned, this has cause significant confusion for many undergraduates. The breadth of curricular offerings and courses within the Geosciences is not adequately captured by the GEOL prefix, as it is not apparent to many students that courses in climate, water resources, landscape/surface processes, and environmental chemistry would be housed under the GEOL prefix. To better promote our visibility in the fields, and to address the strong student interest in a curriculum that provides the basic scientific training in sustainability and environmental issues, we will propose to return all undergraduate and graduate courses in our curriculum (outside purely GEOG courses) to the GEOSCI prefix. To avoid the case of interdisciplinary courses being overlooked by students, these courses can be listed as "shared sections" from both GEOG and GEOSCI. We hope to have this change in place for the Fall 2016 semester.

(3) A third step we can take to improve communication and coherence involves the earth systems major. In recent years, the number of students declaring this major has been declining. We feel that this is a likely result of the growth the Environmental Science major (co-housed within the Department of Geosciences) as well as a lack of clarity among students about what this major, and this field, entails. As such, we propose to suspend this major at least temporarily and roll its curriculum into the existing Geology major. Moreover, we will propose to rename our Geology major as the Geosciences major. As these changes will involve approval from the Geosciences department, CNS, Faculty Senate and others, we will begin the process of these changes this academic year and hopefully have the name change completed by the 2017/18 academic year.

(4) Fourth, we propose to phase out the teaching of GEOL 105 (Dynamic Earth, prior to Fall 2014 known as GEOSCI 105) and reallocate those teaching resources towards teaching an additional section of GEOG 100 (Global Environmental Change, which will be cross-listed as GEOSCI 110 / GEOG 100). GEOSCI 110 will thus be taught every semester, instead of the current fall-only offering. There is substantial overlap between GEOL 105 and the core introductory course GEOL 101. Through advising and other communications, we will redirect

students who might have taken GEOL 105 to either GEOL 101 or to other introductory geoscience courses.

(5) Lastly, together with the name change from geology to geosciences, we are proposing a re-organizing and re-focusing of the major. We seek to increase attraction of students to our major, especially from groups typically under-represented in the geosciences and in STEM fields in general. We are proud that retention once in the major is not an issue; once students find the geosciences, they like the experience and career opportunities it provides. In part because of lack of visibility of geosciences in K-12 education, we recognize that we need to invest in more deliberate and focused branding of our major to graduating high-school seniors and first-year students. Additionally, because UMass is not located in an oil/gas or other resource-extraction state (where undergraduate geology programs are growing), we need to emphasize the skills, concepts and competencies in our undergraduate curriculum that serve the needs of our graduating geoscience majors for employment and future education. This will not come at the expense of a broad geologic training that trains students to be competitive in the national workplace that has significant job opportunities in geologic hazards, mineral exploration and petroleum resources. This re-focused emphasis thus includes not only traditional geology curriculum, but also offerings in water resources, climate, landscape processes, geochemistry and geophysics. Fortunately, these offerings exist within our current curriculum (although many are currently electives rather than required courses); unfortunately, many students do not find these offerings.

To better make students aware of the array of career opportunities in the geosciences, to serve the Commonwealth, the region and the nation with well-prepared scientists, and to serve a student body with a growing interest in an education and future careers in sustainability, we propose to reformat our undergraduate geoscience major. The reformatted major will likely comprise:

(1) A small suite of core courses (3-4) taken by all geoscience majors.

(2) A division of the major into a set of concentrations, such as geology, hydrology, climate, geochemisty, geophysics, and landscape processes. Each concentration may require a suite of 4-5 required courses. There will be overlap of some courses between concentrations, and all courses for these concentrations can be drawn from our existing course offerings.

(3) The remainder of geoscience major credits will be achieved through supporting sciences courses, as is done presently, as well as upper-level undergraduate and graduate geosciences electives.

No additional or new courses are proposed, although the frequency of some course offerings may need to be increased (bi-annual to annual, for example). This is a significant change for the geosciences program, and will likely require some time to achieve. First steps will involve formalizing the proposed changes in curriculum and concentrations within the Department (Which core courses? Which concentrations with which required courses?), followed by the CNS curriculum committee, the Registrar and the Faculty Senate. We are beginning the process now, and will proceed as rapidly as possible.

3b. ***Actions requiring additional resources***

While there are steps that the Geology and Earth Systems programs can take to improve student outcomes within our existing resources, we recognize that substantial changes with more significant improvements to student outcomes will require additional resources.

(1) Among these is the issue of hiring lecturers and increasing TA allocations as a means to improve the teaching effectiveness and student outcomes in our 100-level course offerings. At present, we are limited to offering only section per semester of courses such as GEOL 101 and 103 as well as GEOG 100; TA allocations are insufficient to support graduate student-led lab or discussion sections in any 100-level course except GEOL 101. Yet recent enrollments and past experience shows that these courses fill, and additional sections of these have filled in the past (e.g. Oceanography – GEOSCI 103 – was taught in the past as two 300-person sections each semester, and the course was full). Additionally, SRTI survey results suggest that our teaching effectiveness is lower in large-enrollment courses compared with other CNS departments, while at the same time we actually teach more larger-enrollment courses than our peer departments. We could improve student outcomes and learning by teaching more sections of our introductory courses, each with lower enrollment capacity. However, at present we do not have the faculty resources to do this; as faculty are also need to teach upper-level major courses and graduate courses. Our teaching load per tenure-stream faculty (in both credit hours per instructor and course sections per instructor) is already among the highest in CNS. So while we see a means to improve our teaching effectiveness, and thus improve student learning in the geosciences, we can likely only achieve this by hiring additional instructors. Tenure-stream faculty hires are likely, but we also plan to integrate non-tenure-stream lecturers who could be dedicated to the effective teaching of a small number of undergraduate courses.

(2) Additionally, we recognize that clarity of communication between faculty and students, and student engagement through research and mentoring, is essential. Many departments have dedicated financial resources to a hired non-tenure stream faculty member whose chief role is a program manager and chief undergraduate advisor, and for programs with large numbers of majors there may be entire staff and offices dedicated to undergraduate advising. In contrast, undergrad advising of the geology and earth systems majors has up until now been achieved entirely through efforts of tenure-stream faculty with no staff support. Moving forward, we will propose resources to hire a lecturer who, in additional to teaching responsibilities, will be charged with serving a program manager and chief undergraduate advisor for the geosciences major.

(3) **Actions addressing Building Needs.** It goes without saying that large parts of Morrill are not a "destination of choice". The curriculum in geosciences and the perceptions of our majors is currently compromised by the quality of our classrooms – even the restrooms in the building are horrible. We have lost 6 teaching/laboratory classrooms in recent years due the need for research lab space and the addition of the Northeast Climate Center/Climate System Research Center. The Intro Geology Laboratories are current taught in a horrible space in Hasbrouck that we hoped was temporary.

We have working closely with the CNS office to develop plans for recovering dry laboratory space for an introductory geology/physical geography/geomorphology class room as well as a remodeled computational geology classroom and new GIS teaching lab. More over we are actively in conversation with CNS about developing new, shared wet laboratory space (shared with 3 other departments) to enrich several of our upper level courses for all of our majors including Environmental Science.

Focus on Undergraduate Curriculum and Student Experience:
Department of Geosciences, Fall 2015
Geography (BA, BA with concentration in Environmental Geography, BS)

Report by the Geography Curriculum Committee, Nov. 20, 2015:
chair: Piper Gaubatz
members: Stan Stevens, Eve Vogel, Qian Yu

Part One. Analysis of Current Curriculum

1A. Curricular coherence and accessibility

The Geography BA, BA (concentration in Environmental Geography), and BS degrees will all have clear course sequencing once we restore our introductory physical geography course and change the number of the current Geography 100 course to be Geography 110 (see below). The proposed new concentrations in the Geography BA and BS degrees (discussed below in Part Three) will also have careful course sequencing.

Accessibility of courses, however, is a major issue. There is a significant problem with the availability both of foundational courses at the 100 and 200 level and a number of core courses at the 300 and 400 level. Due to faculty attrition a large number of courses, including foundational 100 and 200 level gen-ed courses, are either not offered at all, are rarely offered, or are not offered regularly enough to meet program curriculum needs and student demand. The problems created by the dramatic downsizing of the Geography tenure system faculty in recent years are compounded by an insufficient number of lecturers or of reliable funds for the hire of temporary lecturers.

Under current arrangements the departmental Geosciences budget does not allocate any dedicated funds for the Geography program, such as earmarking revenue from continuing education courses for the use of temporary Geography teaching. This makes it extremely difficult for the Geography program to be able to plan its curriculum and advise students because we do not know what resources will be made available to us in any given year to hire temporary lecturers. We appreciate that the Department has funded some temporary teaching in Geography. It would be ideal to formalize this support going forward in order to facilitate curriculum planning for coherence and accessibility.

Lack of replacement of retired and deceased tenure system faculty has meant that we have at least temporarily lost our introductory physical geography course (see Part Three) and a set of sustainability and international regional courses at the 300-400 level. Our introductory human geography course (Geography 102) and world regional geography course (Geography 220) are now being taught by a temporary lecturer whose contract expires after Spring 2016 semester. A hire of a full-time lecturer in human geography is urgent to ensure that these courses continue to be taught next academic year.

1b. Clarity of communication

Geography is a small program with faculty members who are highly dedicated to undergraduate education. As a result we have a high degree of faculty-student interaction that provides considerable feedback. We have also established a practice of providing extensive, individualized advising, which also

offers us a chance to gain feedback on the program.

The geography program has made significant improvements in communicating with undergraduate students over the past five years.

- Web presence: The curriculum and associated materials, such as information about job opportunities, are available through a stand-alone website which can be accessed on its own or from the Geosciences Department homepage.(blogs.umass.edu/umgeog).
- Email: The Chief Undergraduate Adviser (CUA) sends regular emails to majors to communicate program news and information, and to advertise course offerings.
- Dedicated space: Most upper-division courses, and discussion sections for lower-division courses, in geography are held in Hasbrouck 236, the geography teaching lab. Information for majors and potential majors is regularly posted in that room.
- In-person advising: The CUA meets with each major for 20-30 minutes during course registration to check in on progress and opportunities. Appointments with the CUA are made online via setmore.com.
- Classes: Two upper division classes – Geography 314 Writing in Geography and Geography 486 Field Methods/Integrative Experience limit enrollment to Geography majors and include focused discussions on professional development and career opportunities for geography majors.

1C Class size goals by student level

Class size in Geography courses accords well with the university's aspirational goals for class size and undergraduate student experience. Our 100 and 200 level foundational courses, which also serve as campus gen-ed courses, average 200 students. We offer a number of 300 and 400 level courses which normally have enrollment under 25 students. Our Junior year writing course and our Senior year Integrative Experience course have fewer than 15 students.

Part Two. Goals for Student Learning and Student Experience

Response 2. Goals for Student learning and alignment with Strategic Plan Priorities in Diversity and Internationalization

We have revised our Geography learning goals statement from the one developed in 2013. The revised set of learning goals (see attachment) more accurately reflects our current curriculum. These goals will be shared with students for feedback and will inform the Geography program survey we will begin to conduct in Spring 2016 with graduating seniors.

Diversity and internationalization are central themes within the field of Geography. All of our human geography courses engage with these in one way or another. Geography makes substantial campus-wide contributions in these areas, particularly with the teaching of general education courses such as Geography 102 – The Human Landscape, and Geography 220 – World Regional Geography, which are both gen-ed Global Diversity courses. Both courses highlight diversity, equity, and justice issues in the US and internationally while introducing students to geographic variation worldwide in culture, society, economy, and environment. We also offer regional geography courses, although our curriculum in international regional studies has been greatly diminished by faculty attrition. (While we still offer a regional geography course on East Asia, we have lost our regional courses on US and Canada, Latin America, Europe, and

Southeast Asia). All geography majors are required to carry out research on racial, ethnic and income diversity in Holyoke as part of our Integrative Experience field methods course. Moreover, courses such as "Climate Crisis," "Urban Issues," and "Geography, Policy and Environment," and "Indigenous Peoples and Conservation, to give a few examples, engage directly with some of the world's most pressing and enduring issues, including climate change, uneven development, and environmental and social justice. We also encourage majors to participate in study abroad and other experiential learning. Our proposed Geography BA concentration in international studies will require study abroad or other international experience.

Part Three. Curriculum Revision Plan

Response 3a. Actions that can be taken now, with existing resources, to address priorities in part One, 1a-1c)

1. Provide a set of concentrations in both the Geography BA and BS degree programs

In line with current university initiatives, the core strengths of Geography as a discipline, and student interest we plan to offer an expanded menu of options beyond our current three choices (see table below). These concentrations will enable students to choose from among sets of courses that best meet their learning interests and career aspirations and will enhance their career preparation.
All BA and BS degree concentrations will have the same structure as our general Geography BA and BS degrees -- 8 credits in 100 level foundation courses, 4 credits at the 200 level (where appropriate), 12 credits in methods, 12 credits in concentration core courses, and additional required elective credits. This ensures that all students have a solid foundation in Geography and geographic methods and skills. Some concentrations will have experiential learning requirements or electives, which can include credits earned from experiential learning courses, internships, study abroad, and independent studies or practica.

We will propose the following options for undergraduates:

Current Degrees Options	New Degree Options
BA - General Geography	BA - Human Geography
BA concentration in Environmental Geography	BA concentration in Environment and Sustainability
BS - General Geography	BA concentration in International Studies
	BA concentration in Climate Change and Society
	BA concentration in Urban Geography
	BA concentration in Geographic Information Science and Technologies (GIST)
	BS - Physical Geography
	BS concentration in Geographic Information Science and Technologies (GIST)

2. Re-establish an Introductory Physical Geography Course (Geography 100) and Renumber Global Change (as Geography 110)

The current version of our Geography 100 course (Global Change) is a valuable course for both Geography and Geology majors, but no longer serves our Geography BA and BS degree programs as a foundational course in physical geography. We have required this course of all Geography majors (BS and BA) as an introductory course that integrates the three core subfields of physical geography: biogeography, geomorphology, and meteorology/climatology. However, over the years this course has

evolved into one focused on climate change and associated global earth system changes. We plan to renumber this Global Change course as Geography 110 and to re-establish Geography 100 as a large enrollment required introductory physical geography course for our majors. As a gen-ed physical science course, the revised Geography 100 (tentatively titled Planet Earth: a Physical Geography) should also contribute to the Environmental Science major.

The Global Change course, renumbered as Geography 110, will logically follow the introductory physical geography course (Geography 100), and the introductory human geography course (Geography 102) in the curriculum. We plan to list it as Geography 110 in order for it to follow other large gen-ed introductory courses that we hope to offer in the future such as a course in Sustainability and a course in International Development in the 104 – 108 course number range.

With the retirement of Professor McCoy there are no physical geography faculty left in the department to teach the foundational physical science course in our academic discipline. However, the introductory physical geography course can be taught on an interim basis by existing Geosciences faculty, such as by the geologist hired to replace retiring geographer William McCoy. Ultimately, this course should be taught by a physical Geography tenure system faculty member (see below) or by a physical geography lecturer.

3b gaps that can only be addressed with additional resources

1. Offer foundational, large gen-ed courses on a timely basis

This requires the hire of lecturers in physical and human geography as described in our strategic planning documents.

2. Enhance teaching program teaching with increase in number of teaching assistants.

The Geography program suffers from inadequate TA support. We receive 3 TAs per year from the department, and for the past two years have been awarded an additional 0.5 TA from the Provost's office as part of her support for general education diversity courses. At this level of TA support we provide laboratories or discussion sections for only one of our 100 and 200 level courses (Geography 102, the introduction to human geography). There is no lab for Geography 100 (introduction to physical geography) because of lack of TAs for one. None of our courses above the level of 102 have TAs except for our GIS and remote sensing courses, regardless of the number of students in the course or the amount of grading, field trip organization, and other work involved. Our program would be enhanced by provision of at least 1 full TA for every 100 or 200 level course and 2 TAs for those that have 150 or more students with labs or discussion sections. TA support for large 300 and 400 level courses and for our field course would also enhance undergraduate learning. At a minimum the provision of 4 additional TAs per year would enable us to have labs for our introductory physical geography course (Geography 100) and discussion sections for our world regional course (Geography 220).

3. As per the Geography strategic plan, strengthen our sustainability and international studies faculty through replacing retired and deceased faculty with research and teaching foci on sustainability and on international studies.

While we can continue to offer our Geography degrees and the proposed concentrations with efficient, carefully organized use of our current faculty resources, our degree programs will be strengthened

through replacement of faculty positions focused on sustainability and international studies that have been lost in recent years through retirement and death.

Courses that are not now being taught because of faculty attrition (and also from resulting reallocation of required curriculum and gen-ed courses among remaining faculty) include several large enrollment 100-200 level gen-ed courses (Introduction to Physical Geography; Natural Disasters; US and Canadian Geography; and New England Geography) and a large number of 300-500 level courses that would add considerably to our Geography degree concentrations and campus initiatives on diversity, internationalization, and sustainability. These include Latin America Geography, Southeast Asia Geography, Geography of Europe, Population and Environment, Development Geography, Economic Geography, Community Economies, Land Use and Society, and Ecological Cities. We hope to offer new courses on Sustainability and on Climate Policy. When expanding our faculty and curriculum in the future, we hope to maintain a strong focus on internationalization, environment and sustainability. The need for more Geography faculty has been stressed in the Geography strategic plan, the departmental strategic plan, and two AQAD reviews since 2005.