Environmental and Earth Science Self Study 2019

Contents

Executive Summary of Comprehensive Plan for Improvement

The Earth and Geographic Sciences Department, composed of six full time faculty members, offers majors in Environmental and Earth Science (EES), Environmental Public Health (EPH), and Geographic Science and Technology (GST). We also house Physics.

The department has undergone substantial changes since the previous self study. One-third of our full time faculty members retired, and new faculty members have been hired to fill the openings created by those retirements. We have changed the name and curriculum of our Environmental and Earth Science (EES) major, previously called Earth Systems Science. We have also added a new major (Environmental Public Health) and two new minor programs (GIS minor, GIS Crime Mapping and Analysis minor).

We have seen enrollment in the EES major double since the previous self study (AY14; Appendix B), which we attribute primarily to the new name and focus of the major. Despite this, we still see relatively low numbers of incoming students, both freshmen and transfers, who declare EES as their major, and we would like to continue to increase the number and diversity of our students overall. We plan to increase our recruitment efforts at high schools and community colleges to attract more students to our department, and continue to expand retention efforts for our current students.

We have many of the resources that we need to support our teaching and research, which has allowed us to keep pace with emerging disciplinary developments, particularly related to geospatial technology. As a result, our students have a variety of participatory learning opportunities and field experiences through coursework, internships, and independent research. To expand these opportunities to all students in the department, faculty are in discussion about adding a required capstone experience for the major. In addition to considering a capstone, faculty in the department are in the process of expanding our curriculum to include courses that we have identified as gaps, as well developing study abroad opportunities.

As a relatively small department, we are able to create an engaging and supportive environment for our students, and faculty members from our department have developed strong collaborations with other departments to expand teaching and research opportunities. While we do, at times, have an active student club, the department lacks a consistent offering of extracurricular activities. Faculty in the department plan to work with students to support their efforts to maintain an active student club, and will begin to organize more departmental social and outreach events to build community.

Overall, we have noted substantial expansion and strengthening of our programs in the past five years, and will employ a variety of strategies to continue to grow as an academic community.

1. Overview and vision

1.1. Overview of department

The Department of Earth and Geographic Sciences offers majors in Environmental and Earth Science, Environmental Public Health, and Geographic Science and Technology. Minors are offered in Earth Science, Geographic Information Systems, Geographic Science and Technology, and GIS Crime Mapping and Analysis. We also house Physics, offering service courses to our majors and those of other departments.

Our faculty's expertise includes geology, oceanography, hydrogeology, planetary science, climate change, geospatial technologies, geographic information systems, and physics. This diversity ensures that graduates emerge with a dynamic understanding of these disciplines.

There are currently (Fall 2019) six full time faculty members in the department: three full time earth science faculty (Drs. Clark, Gordon, and Parsons), one full time geographic science faculty (Dr. Huang), and two full time physics faculty (Dr. Yu and Ms. Morin). A new tenure track faculty member in physics will join the department in Fall 2020. Adjunct faculty members support the teaching of general education and major courses in the department. We typically have 4-6 adjunct faculty members per semester, primarily for geography and physics. Faculty rank and demographic information are provided Appendix F.

During AY14-15, the time of our last review, our department had just moved to the new Antonucci Science Complex and, as now, we had six full time faculty members and supported the teaching our courses with several adjuncts. There has been some flux in staffing since that time: two of our full time, tenured faculty members retired and one took a two-year research leave. Dr. Larry Guth, who taught both Earth Science and Physics, retired in 2017, and Dr. Bruce Duncan, a physicist, retired in 2019. Dr. Reid Parsons, hired in 2013, took a two year leave of absence during AY17-18 and 18-19 to conduct research in Japan; he returned to the university Fall 2019.

After Dr. Guth's retirement, we conducted a search for a full-time, temporary Physics faculty member, and hired Ms. Tina Morin in August 2017. During AY17-18, we hired three new adjuncts to cover Earth Science courses while we conducted a tenure-track search for an earth scientist. That search led to the hire of Dr. Elyse Clark, a hydrogeologist, who joined the department in Fall 2018. With Dr. Clark's hire and Dr. Parsons's return in Fall 2019, we are now fully staffed to offer courses for the Environmental and Earth Science major, as well as courses that contribute to the Geographic Science and Technology and Environmental Public Health majors. This past academic year (AY19-20), we conducted a search for tenure-track physics faculty member to fill the position left by Dr. Duncan's retirement; Dr. Jared Vanasse will join the faculty in Fall 2020.

Student enrollment in our department has increased since our previous review period. We currently (as of Fall 2019) have 47 of majors overall, with 37 Environmental and Earth Science majors and 10 Geographic Science and Technology majors. This represents a doubling of the number of students since our previous review: during AY14, there were 24 majors total. There are currently 21 students earning minors in the department – six in Earth Science, seven in Geographic Information Systems, and eight in Geographic Science and Technology.

Since our previous self study, we have modified the name and curriculum of our earth science major. To begin, we changed the name of the major from "Earth Systems Science" to "Environmental and Earth Science" to highlight the environmental focus of our curriculum. We increased the number of required courses from six to nine, and concomitantly decreased the number of elective courses from six to three. This change ensures a core of content knowledge for the majors, and has helped to address the problem of under-enrolled upper division courses. The revisions were made after extensive consultation with Biology colleagues, especially those who teach in the environmental biology curriculum. Additional details about curriculum changes can be found in section 1.7.1.

Our department also added an Environmental Public Health major, effective Fall 2019. The new major grew out of a collaboration between Dr. Jane Huang and Dr. Debbie Benes (Nursing), who first suggested the creation of a program focused on applying geographic technologies to public health concerns in AY16. Dr. Meg Hoey, Dean of Health and Natural Sciences, convened a group of faculty from the sciences and mathematics to discuss alternative STEM pathways for students at Fitchburg State, including environmental public health. Dr. Liz Gordon, chair of the department, coordinated discussions among faculty from Health and Natural Sciences as well as from Arts and Sciences during AY17 and 18. EPH, as a new major within the Earth and Geographic Sciences Department, passed through university governance in May 2018. The Fitchburg State University Board of Trustees gave final approval in August 2018 and the Massachusetts Board of Higher Education approved the new major in March 2019. The BS degree in Environmental Public Health is intended for students who are interested in the health sciences but seek an alternative health profession beyond those offered through Nursing or Exercise and Sports Science (EXSS).

1.2. Program's vision, mission, and objectives

1.2.1 Department vision

The Earth and Geographic Sciences Department seeks to prepare students as critical thinkers to engage with global environmental challenges through the study of earth, environmental, and geographic sciences. The department cultivates the intersections of our academic majors while also deepening our individual programs. Faculty and students serve our local and regional community via course-based projects and independent research. We value leadership, a culture of sustainability, lifelong learning, and promotion of sound scientific principles, and recognize the indispensable role that the study of nature has in a liberal arts education.

1.2.2 Department mission

Students in the Earth and Geographic Sciences Department will develop a rich understanding of Earth's natural and social systems by cultivating analytical skills in the field, classroom, and laboratory environments. Programs in the department are designed to allow students to explore their interests with experiences that bring together theory and application, contribute to scholarly development, and prepare students for a range of career pathways.

1.2.3 Environmental and Earth Science objectives

Students who earn a major in Environmental and Earth Science will demonstrate a scientific understanding of how the Earth operates as a system and how humans interact with their environment, including natural hazards and use of Earth's resources. They will be able to distinguish between science

and non-science, back up arguments with quantitative evidence, communicate their ideas effectively, and explain the necessity and characteristics of an interdisciplinary approach to solving environmental issues.

In particular, Environmental and Earth Science students will:

- communicate scientific information through written, oral, and graphical expression with clarity, logical organization, and use of scientific evidence to support their ideas.
- use the scientific process, including experimental design, analysis and critical evaluation of information, and integration of evidence from relevant sources, in the context of environmental investigations.
- discuss the structure and composition of Earth's interior, surface, and atmosphere, and explain what it means to consider Earth as a system.
- apply an interdisciplinary approach to analyze and propose solutions to environmental science problems.
- describe the complex interactions between humans and their environment, including geological hazards, air and water pollution, global environmental issues, and use and conservation of Earth's resources.

1.3. Relationship to the university mission, vision, and strategic plan

The Earth and Geographic Sciences department's mission and vision aligns with key aspects of those of the University. For example, part of the department's vision to 'prepare students as critical thinkers to engage with global environmental challenges' supports the university's aim to 'prepare students for a global society' as well as its mission to 'prepare[s] students to lead, serve, and succeed by fostering lifelong learning and civic and global responsibility.' Similarly, our department's vision highlights that our 'faculty and students serve our local and regional community via course-based projects and independent research', which aligns with the university's goal to 'build partnerships within our community to provide real-world opportunities for our students and collaborative solutions to community issues.' The Earth and Geographic Sciences department, along with other departments on our campus, share the University's commitment to teaching and learning excellence, and contribute toward the liberal arts and sciences education of all students on our campus.

1.4. Overview of program

This self study focuses on the Environmental and Earth Science (EES) major within the department. There is no national standard curriculum for geoscience programs - some retain a traditional geology curriculum, while others incorporate an earth systems or environmental approach. Our curriculum is designed with Environmental Earth Systems Science at its core, and incorporates a strong geospatial analysis component. Detailed outcomes are provided in the Assessment Plan (Appendix A). In brief, students develop knowledge and skills as follows:

To gain content knowledge in the **physical environment**, students take six courses:
GEOG1000 *Earth Systems Science,* **OR** ENVS1000 *Introduction to Environmental Science*
GEOG2100 *Geology*
GEOG2500 *Oceanography*
GEOG3110 *Climatology*
GEOG4200 *Geomorphology*
GEOG4600 *Environmental Hydrogeology*

To develop skills in **environmental spatial analysis**, students take three courses:
GEOG2400 *Introduction to Geospatial Technologies* OR GEOG3120 *Computer Cartography*
GEOG4000 *GIS*
GEOG4500 *Remote Sensing of the Environment*

To understand **environmental interactions and applications,** students choose three courses from the following:
GEOG2200 *Meteorology*
GEOG2056 *Climate Change and Human History*
GEOG4220 *Structural Geology*
GEOG4700 *Geographic Perspectives on Conservation*
GEOG4900 Independent Study in Geo
GEOG4940/50/60 Internship in Geo
BIOL1900 *Gen Bio II* OR BIOL2100 *Flora of New England* OR BIOL3100 C*onservation Bio* OR
BIOL3102 *Marine Biology*
ENSC2000 *Field Techniques in Environmental Science*
ENSC4050 *Internship in Environmental Science*

Required cognate courses allow students to integrate knowledge from various fields to address environmental problems:
PHYS2300 and PHYS 2400 General Physics I and II
CHEM1300 and CHEM1400 General Chemistry I and II
MATH1700 Applied Statistics
MATH1300 or 2300 Precalculus or Calculus I
BIOL2300 *Ecology*

The curriculum is designed to balance a breadth of knowledge about the Earth System and depth of knowledge about earth system processes. The curriculum includes cognate courses from mathematics, chemistry, physics, and biology, so that students establish a base of scientific knowledge and quantitative skills. The core introductory courses in the curriculum - Earth Systems Science, Introduction to Geospatial Technologies, Geology, and Oceanography - allow students to develop their foundation in earth science principles. Upper division courses promote a deeper understanding of the Earth system: geosphere via geomorphology, hydrosphere via hydrogeology, atmosphere via Climatology, and spatial analysis via GIS and Remote Sensing. Students may then tailor their knowledge depth by selecting three electives. In the process of reworking the major requirements, our department identified gaps in the EES curriculum, discussed in section 1.7.1.

As mentioned, there is no standardized curriculum for geoscience programs nor is there a formal set of best practices adopted by all departments. Some geoscience departments adhere to a set of best principles[1], which include five academic and five administrative principles. The five academic principles include: 1. skill training and construction of the knowledge base; 2. Thoughtfulness and critical analysis; 3. Participatory educational experience; 4. Earth systems and societal-environmental interaction; 5. Comprehensive general education. The EES program at Fitchburg State addresses each of the five.

[1] Drummond C.N. (2001). Ten common principles of geoscience departments - Part I. Journal of Geoscience Education, 49, 108.

The first - knowledge base and skill training - is represented by a thoughtful consideration of courses to include in the core of our major curriculum. Those courses set the foundation in content knowledge in each of Earth's spheres (geosphere, hydrosphere, atmosphere, and biosphere), with advanced coursework focused on processes that operate in the Earth system. The curriculum is designed to incorporate quantitative and scientific inquiry skills into all courses, and our upper division courses focus on geoscience methods as well as oral and written communication skills. Finally, three required courses are devoted to geospatial analysis skills. The second principle, critical analysis, is similarly practiced and honed as students engage in scientific thinking in all courses, and apply these skills to real-world problems. Many of our students have the opportunity for a participatory experience, the third principle, by completing an internship, independent research with a faculty member, or a community-based exercise that is embedded into required courses such as *Introduction to Geospatial Technologies* or *Geographic Information Systems*. The fourth principle - Earth systems - is at the heart of our major, with a curriculum founded on a deep understanding of all spheres and human interactions. Finally, our department contributes to the general education of all students by offering introductory and intermediate courses that focus on scientific thinking and inquiry and application of geospatial technology to address environmental and social issues. We offer several interdisciplinary, co-taught courses, such as *Climate Change and Human History* and *GIS for Criminal Justice*. Our department also offers a course that is required for the Honors program (*Honors Seminar in Environmental Science)*. A First Year Experience (FYE) course will be a general education requirement for all incoming students with fewer than 30 credits beginning Fall 2021; our department has already created and passed through governance a FYE to contribute to this general education requirement.

Just as the department contributes to the general education program of all Fitchburg State students, the EES curriculum is supported by general education courses offered by other departments. As noted, EES students are required to take courses in cognate departments, such as Biology/Chemistry and Mathematics. The general education program of the institution, referred to as our Liberal Arts and Sciences (LA&S) program, provides foundational skills in written communication, information literacy, and quantitative reasoning, which are further developed in their major courses. Students also gain disciplinary breadth by completing courses in the Humanities, History, and Social Sciences.

1.5. Internal demand of the program/department

Enrollments in courses offered by the department, including physics, has varied between 723 and 808 since AY13 (Appendix B). These numbers account for 2.1-2.4% of total enrollment at the university. The number of EES majors has grown from 13 students in AY13 to 37 students in AY18. During the past five years, we have had between 5 and 12 students who graduate with a declared minor in Earth Science. The Geographic Science and Technology (GST) major has grown from three in AY16 to a peak of 12 in AY17; there are 10 declared majors as of Fall 2019. The number of GST minors has varied between 6 and 12, while Geographic Information Systems (GIS) minors has varied between 5 and 11 since its inception in AY16. As of Fall 2019, there were no data available about the GIS and Crime Mapping minor owing to its recent addition the curriculum.

Other programs that require EGS courses
General or Calculus-based Physics is required of students who major in Environmental and Earth Science, Biology, Chemistry, Applied Mathematics, and Engineering Technology. Although not required of Exercise and Sports Science students, those who are interested in pursuing a career in Physical Therapy or as a Physician's Assistant enroll in physics, as do some Computer Science students. Students seeking a BA rather than a BS in Biology can opt to take Physical Science rather than General Physics.

Students earning a degree in Environmental Biology are required to complete two GEOG courses. Courses from our department are also required for students completing the Interdisciplinary-General Science major, as well as the Middle School Education-General Science major.

General education courses
Non-majors enroll in many of our courses to satisfy their general education requirements, as described previously. Our department offers 23 courses that contribute to the LA&S requirements, listed in Appendix C.

1.6. Recommendations and actions from previous review

The external reviewer from the previous review, during Spring 2015, made recommendations that can broadly be categorized into: enrollments, curriculum, space utilization, and faculty.

1.6.1 Enrollments and recruitment

The reviewer noted the need to increase the number of majors, and suggested an improved marketing plan along with ensuring that our best instructors are teaching the courses from which we recruit. Since then, we have seen our enrollments in EES increase from 18 in AY14 to 37 in AY18. We attribute the increase primarily to the name change, but the addition of faculty with broader environmental interest has likely played a role as well. For EES, we are now in a position for our best instructors to teach our introductory courses. For GST, we still rely on an adjunct to teach our introductory and upper level social geography courses. We have requested a new geography line every year since the previous review, and will continue to do so partly to ensure that a full-time faculty member is teaching courses from which we can recruit new majors. In the meantime, we will encourage our adjunct faculty to assist in our recruiting efforts.

We have improved marketing efforts within the department. Dr. Huang devoted considerable time and energy to improving the department website, and continues to provide content to keep the website current. Dr. Parsons created a departmental Facebook page, on which we post announcements and news. Dr. Clark recently created an Instagram account for the department to increase our social media presence.

The department chair meets at least once each year with staff in Admissions to share information about new initiatives and programs. The department continues to work with admissions on developing new materials for recruitment events, such as open houses, and we participate in other potential recruitment events, such as Early College and Sizer student programs.

Admissions created a recruitment video focused broadly on environmental research opportunities; one of the students from EES was interviewed for the video. Other students have been highlighted in university publications, such as Contact magazine, and in local media. Faculty in the department continue to discuss additional recruitment efforts, and we are acutely aware of the bleak projections regarding university enrollments overall in the years ahead.

1.6.2. Curriculum

The previous reviewer suggested several considerations with regards to the curriculum, including course offerings that will help recruit the most majors, and modification to the major curriculum that is less

likely to, in his words, 'scare off students'. He specifically suggested a greater centralizing focus for both majors.

We continue to recruit from our introductory courses, *Earth Systems Science* and *Introduction to Geospatial Technologies*, as well as from our 2000-level lab courses, *Geology*, *Oceanography*, and *Meteorology*. We have developed one new course, *Environmental Geology*, which may assist with recruiting majors, and another new offering (Spring 2020), *Water Resources and Society*, is also likely to attract new majors.

We have reworked the curriculum around a centralizing theme of Environmental Earth Science. Students build foundational knowledge of earth's spheres in their 1000 and 2000 level courses, and begin integrating knowledge and learning earth system processes in their upper division courses (climatology, geomorphology, hydrogeology). We have also integrated more technology into the program, adding *Remote Sensing* as a required course. The required core of the major is now nine courses instead of six; electives have been reduced from six to three to maintain the total number of required courses at 12. While the number of electives have been reduced, we expanded the pool from which students can choose to fulfill their elective requirements. In particular, students may choose to fulfill one of their electives by selecting an environmentally-themed Biology course, such as *Conservation Biology*. We will continue to expand the elective options as new courses are developed, such as *Environmental Chemistry* and *Soils and the Environment*.

1.6.3. Space utilization

The reviewer recommended better use of, and improved signage for, our existing spaces. We have increased use of the geoscience research lab (SCI129) and added signage to indicate its current designation as an Aquatic Geochemistry Lab. We have added computers to SCI317, which has become the GeoSpatial Research Lab and have expanded some of geospatial research into the adjoining space, SCI319. The latter will revert to a physics research space for use by our new tenure-track physics hire in Fall 2020.

1.6.4. Faculty

The reviewer noted the need for an additional Geographer in the department, with the caveat that it be connected to a redesigned program. The GST major has undergone revision since the previous review, and Dr. Huang continues to offer all of the GIS-based courses required of all three of our programs. As noted above, the department has requested a geography hire every year since the previous review, but it has not yet been approved.

The reviewer recognized the difficulty of sustaining faculty lines in physics when they are only able to teach introductory physics courses. We anticipate a greater demand for Physics, and perhaps additional teaching opportunities, with the revisions that are taking place especially in Engineering Technology. As the Chemistry program grows, we also expect enrollments in our calculus-based Physics sequence to increase. We do not anticipate adding a Physics major in the foreseeable future, but we would like to consider adding a minor, either as a standalone Physics minor or an interdisciplinary minor with a cognate department such as Engineering Technology.

1.7. Program initiatives and change since previous review

1.7.1. Curriculum changes

As mentioned previously, we changed the name of the major from Earth Systems Science to Environmental and Earth Science, which clarifies to external constituents the focus of our curriculum. The requirements for the major were modified to reflect the increased focus on the environment, as well as to solidify the curricular structure such that students are required to complete more upper division courses. As noted before, the core required courses for the major were increased to nine from six, at the expense of the number of electives (from six to three). While students have fewer electives, the choices to fulfill those electives have been expanded to include environmental biology and chemistry courses. We continue to diversify course offerings in our department to fill what we perceive to be gaps in the curriculum, particularly with regards to courses that are focused on water resources, soils, and geochemical cycling. We are in the process of addressing these gaps with three new topics courses that we will likely seek approval through governance in the next few years: *Water Resources and Society*, offered Spring 2020; *Soils and the Environment*, planned offering Fall 2020; and *Biogeochemistry*, offered Spring 2020. These new courses will initially serve as options for the three electives. Finally, our department developed a course to contribute to the University's First Year Experience, as part of which all incoming students will be required to take a FYE course beginning Fall 2021. Our FYE, *Sustainable Thinking*, will be offered for the first time Fall 2020 as part of a pilot program.

Other curricular changes in the department not explicitly tied to the EES program include the addition of one major (Environmental Public Health) and two interdisciplinary minors (*Geographic Information Systems*, with Computer Science, and *GIS for Crime Mapping and Analysis*, with Criminal Justice). Two new programs on the horizon include a Geoinformatics track within the Computer Information Systems major, and the development of a GIS course for the online MBA.

While there has been an increase in online offerings at the University as a whole, our department continues to offer all required courses in a face-to-face format, excepting conditions in response to a global pandemic. A few of our courses have been offered either fully online (e.g., Climatology) or hybrid (e.g., Oceanography, Meteorology), but the low enrollment in such courses has not justified a substantial transition to the online environment. As a department, we have adopted a policy that labs in particular will continue to be taught face-to-face in order to optimize the learning experience for our students.

Faculty in our department are extending our course offerings to international locations. Dr. Yu has taught Physics in Shanghai during the past couple of summers prior the University's formal agreement with AUIA, a program that offers Fitchburg State courses during the summer in Shanghai. Dr. Chaitanya Hiremath, a physics adjunct, participated in the inaugural year (2019) of the AUIA program. The program will not run in Summer 2020 due to the coronavirus, but we anticipate participating in future years. In addition, Drs. Huang and Clark are currently preparing to offer our department's first study abroad program in Peru during Spring 2022 (initially planned for Spring 2021, but delayed by one year due to the coronavirus).

1.7.2. Scholarly pursuits

Drs. Clark, Gordon, and Huang participated in Fitchburg State's Summer Research Collaborative (SRC), an interdisciplinary community-based project focused on the health of the Nashua River watershed and local communities. The program, which ran from 2017-2019, was designed to improve retention in the sciences by providing a paid research experience for Fitchburg State undergraduates, particularly those of underserved populations. Funding for the program ended in 2019; other funding sources are currently being pursued to continue this program. Faculty research is described more fully in section 2.1.2.

1.7.3. Community outreach

Faculty and staff in the department contribute to the local community through course-based and independent research projects, outreach events, volunteer efforts, and service on local boards.

Dr. Gordon participated in two Community Read events for *The Girls of Atomic City* during AY18: in Sept 2017, she was part of panel discussion regarding the development and consequences of the atomic bomb, and in March 2018, she co-facilitated a book discussion at the Lunenburg Library. She has accepted invitations to lead several community discussions on the subject of climate change, including one as part of a science seminar at Wachushett Regional High School (Feb 2018) and one at the Lunenburg Library (April 2019). She and co-author Ben Lieberman were invited to the Ayer Public Library for a discussion about their book, *Climate Change in Human History*, in September 2019. They participated in a similar (Zoom) discussion at the Boylston Public Library during May 2020. Finally, Dr. Gordon volunteered the Fitchburg Trail Vision committee with the preparation of their Trail Vision Document, which was presented to the City of Fitchburg for approval in March 2020.

Dr. Huang embeds community projects in her geospatial technology courses, and several students have completed community-based internships and independent study projects under her supervision (Appendix E). In 2015, she supervised seventeen students in her *Computer Application in Geosciences* course (now, *Introduction to Geospatial Technologies*) on the GPS Survey of Healthy-Heart Trails Project, requested by the Montachusett Regional Planning Commission (MRPC) Project.

In 2016-2017, Dr. Huang and six student research interns worked on the Neighborhood Property Mapping & Analysis Project in a joint grant with Crocker Center for Civic Engagement, Montachusett Opportunity Council, NewVue Communities and City of Fitchburg. In 2017, she involved four students in the Fitchburg Commercial and Industrial Property Inventory and Mapping project in a joint grant of Crocker Center for Civic Engagement, ReImagine North of Main, City of Fitchburg, and Montachusett Opportunity Council.

The following year (2018), Dr. Huang organized the Ingleside Trail Survey and Mapping Project in Winchendon MA. She supervised twelve students enrolled in her *Introduction to Geospatial Technology* course in surveying and mapping Ingleside trails using GPS and GIS technologies upon the request of City of Winchendon. Also in 2018, Dr. Huang and a student research intern built a web GIS Platform upon the request of the Crocker Center for Civic Engagement, ReImagine North of Main, City of Fitchburg, and the Montachusett Opportunity Council.

For the past two years (2019-2020), Dr. Huang was a co-investigator of the grant project of Worcester County Overdose Death Response Initiative. She and her student research interns were in joint research

coordination with the Middle District Attorney's Office and Fitchburg State University Criminal Justice Program on innovative prosecution solutions for combating violent crime and the opioid epidemic in Worcester County.

Dr. Parsons connects his research to the local community, having met with three groups of cub scouts from Ayer (Spring of 2017, 2020) and Templeton (Fall of 2019) to help them achieve their "Nova award" education merit badges. Dr. Parsons also gave a public talk on "Climate Change on the Red Planet" as part of a celebration of the inauguration of the new University President in Fall of 2016, which was attended by students from a local high school. He spoke about the Earth and Geographic Sciences programs at a meeting with Mount Wachusett Community College faculty and students in Oct. 2016. In addition, Dr. Parsons gave a science seminar talk about his Mars research and the use of spacecraft to study Earth at a talk at Wachusett Regional High School in Nov. 2015.

Dr. Yu has volunteered in the work of the Massachusetts Math & Science Initiative for more than ten years, serving as a physics expert. In this role, she gives lectures in the program's Saturday Student Sessions to students who are taking an Advanced Placement Physics course. She has served as a juror since 2014, and a board member from 2016 to 2019, in the United States Invitational Young Physicist Tournament, which holds an annual physics competition for high school students from around the world. Dr. Yu participated in a Community Read panel discussion event for *All the Things I Never Told You* in March 2019. Dr. Yu was a member of the Fitchburg State Concert Choir from January 2017 to May 2019, singing with the Choir in the annual Spring and Winter concerts. She also participated, by reading a poem, in the Women in the Art performances celebrating Women's Month in March 2018 and 2019. Dr. Yu also read a poem in the International Poem Slam organized by the University's International Office in November 2017 for celebrating our international students.

Ian Murray, our shared (with Chemistry) lab technician, serves on the Fitchburg Board of Health.

Our students have also contributed to the community through a variety of activities. Tallie Foster ('19) organized the March for Science Fitchburg in April 2018 and organized several clean-ups in her role as ELF President. Maeve Ahern ('20), as part of a service learning project, volunteered with the Nashua River Watershed Association (NRWA), assisting with their long-term water monitoring program. Sean Beverly ('19) created a program to print a 3D model of the Nashua River Watershed, one copy of which was donated to the NRWA. Madison Whitten, a Geographic Science and Technology minor, created a travel guide of the New England states to showcase points of interest including hiking/geology-related activities and restaurants.

2. Assessment

2.1. Program ingredients

The Environmental and Earth Science program has at its core a focus on Earth as a system. The curriculum is designed to provide students with a breadth of knowledge about the Earth System and depth of knowledge about earth system processes, along with a foundation in cognate science knowledge (chemistry, physics, and ecology) as well as quantitative skills (mathematics). A unique characteristic of our curriculum is a strong geospatial technology component – students are required to take three courses in which they learn industry standard software programs (ArcGIS, ArcPro, ENVI). The program therefore balances geoscience knowledge with skill- and project-based learning, which enables students to gain skills that are increasingly in high demand by employers and follows current disciplinary

trends. The program also includes field-based work, which the faculty perceives to be an important component of any geoscience program. Importantly, much of our project-based learning and field experiences are focused on the Fitchburg region and tied closely to the local community.

2.1.1. Students

Incoming students must meet the admission requirements of the university. The number of majors overall has grown from 13 students in AY13 to 37 students in AY18 and AY19. We attribute this increase to the name change and associated modification of the curriculum. While the number of majors as a whole shows a positive trend, the number of incoming freshman declaring the major seems to be holding steady between 2 and 4. Like many earth science programs, most of our current students arrive as transfers, either internally from a different major or from another institution (6 -7 students per year). We tend to retain students once they have declared the major, and those graduating with the EES major has increased from a low in some years (AY16 and 17) of 1 graduate, to eight students in AY18 and six in 2019. In this time span, we have had between 5 and 12 declared minors.

Our students are primarily Caucasian, with roughly equal numbers of female and male students. In AY18, 30 students identified as Caucasian, 2 as Asian, 2 as Hispanic, 1 as African American, and 2 as Unknown. Our department is committed to increasing the ethnic diversity of our students, and we realize the challenge in doing so given that Earth Science as a discipline struggles to attract diverse students[2]. As we plan our increased recruitment and retention efforts (section 3.2), we will be intentional about trying to attract students from diverse backgrounds.

Student involvement in the department happens through curriculum experiences, departmental committees and formal activities, and through extracurricular student-run clubs. For example, the department's policy is for two students to serve on our departmental curriculum committee. We attempt to have one student each from the EES and GST majors. For the past three years, one of our student members has served as chair of the curriculum committee. In addition, we often ask for student volunteers to assist with Admissions events, such as Open Houses.

There are two student-run clubs associated with the department: the Environmental League of Fitchburg (ELF; formerly GeoClub), and the GIS club. Student involvement in both clubs is variable year to year. For example, ELF was most active during AY17 and AY18, but has become inactive since the club's recent president graduated.

Many of our students are able to complete an internship or independent research project as part of their curriculum; most of those opportunities are connected to our local community. In the past five years, student have completed internships with local cities and towns (Ayer, Fitchburg, Gardner, and Leominster), with local community organizations (Montachuett Regional Planning Commission, North County Land Trust), educational and scientific facilities (Blue Hill Meteorological Observatory, New England Aquarium) and in partnership with faculty and staff on campus (GeoSpatial Research Lab, Environmental Health and Safety office). During the summers of 2017-19, twelve of our students completed projects as part of the Nashua River Research Collaborative, and several have completed independent study projects with faculty members on campus (Appendix E).

[2] https://www.nytimes.com/2019/12/23/science/earth-science-diversity-education.html

In addition to research experiences, several students have had the opportunity to gain experience as peer educators in our introductory geoscience and advanced geospatial technology courses (Appendix E). Faculty in the department have found this to be an excellent way to support student learning, both from the peer educator's perspective as well as for students enrolled in those courses. The department aims to continue this practice of embedding peer educators, particularly into geospatial technology courses.

Students have the opportunity to present their course-based and independent research at the University's Undergraduate Research Conference. Departmental faculty sponsor several students each year (Appendix E).

2.1.2. Faculty

As of Fall 2019, the department is composed of six full-time faculty members: two physicists, three earth scientists, and one geographer. Half of our full time faculty members are tenured full professors, two are untenured assistant professors, and one is an instructor, i.e., not on the tenure track. The department is 83% female and 17% male, ethnically 67% Caucasian and 33% Asian. Faculty qualifications, CVs, and demographic information can be found in Appendix F; brief descriptions of faculty teaching and research follow.

Dr. Elyse Clark, a hydrogeochemist, joined the department in Fall 2018. Her primary teaching responsibilities include *Earth Systems Science*, *Geology*, and *Environmental Hydrogeology*; she has also taught *Geomorphology* and may teach *Environmental Geology* in the near future. Dr. Clark is developing courses to address perceived curriculum gaps, including a sophomore-level course devoted to water resources and an advanced course on soils. She and Dr. Huang are in the process of developing a study abroad course, *Geology and Environmental Mapping of Peru*, with a planned offering Spring 2022.

Dr. Clark supervised student research as part of the Summer Research Collaborative (SRC), in which students analyzed the hydrogeomorphological characteristics of the Nashua River's tributaries. Dr. Clark currently supervises a student who is analyzing the effects of road salt applications on the chemistry of two Nashua River tributaries; this research will continue to expand and will include more streams in the future. Along with Dr. Justin Richardson at UMASS Amherst, Dr. Clark is collecting and analyzing water, soil, and rock samples to determine how the weathering of schists in the Fitchburg Complex affects water quality.

Dr. Elizabeth Gordon, an oceanographer, joined the faculty in Fall 2007. She teaches courses focused on atmospheric and ocean sciences including *Oceanography*, *Meteorology,* and *Climatology*. She and Dr. Ben Lieberman, an historian, co-teach a course entitled *Climate Change and Human History*. She has shared responsibility for teaching an honors seminar in Environmental Science and for upper level courses focused on sustainability (*Geographic Perspectives on Conservation*). Dr. Gordon is developing a course on *Biogeochemistry*, with an initial offering Spring 2020, and will offer the department's First Year Experience course in Fall 2020.

As part of the Summer Research Collaborative (SRC), Dr. Gordon supervised student research to modify a method of isolating microplastics from water samples in the Nashua River watershed. Students from summer 2019 presented their work at the Ocean Sciences conference in San Diego in February 2020. Also as part of the SRC, students assisted with sample collection for dissolved organic carbon analysis; those analyses will be performed at UMass Boston. Dr. Gordon's other scholarly pursuits include

geoscience education, currently focused on the integration of ocean observing data into undergraduate courses. Also connected to her teaching, Dr. Gordon co-authored, with Dr. Benjamin Lieberman from History, a book entitled *Climate Change in Human History: Prehistory to the Present*. The first edition was published in January 2018, and a second edition is currently in preparation.

Dr. Jane Huang, a geographer, joined the faculty in Fall 2006. She teaches all courses with a geographic information systems (GIS) focus, including *Introduction to Geospatial Technologies*, *GIS*, *GISII*, *WebGIS,* as well as *Urban Geography*. She, along with a faculty member from Criminal Justice (CJ), teach the interdisciplinary course *GIS for CJ*. She is currently developing a GIS course for Fitchburg State's online MBA program.

Dr. Huang has been involved in twelve research grants with dollar values ranging from $100 to $360,000 since 2014. The funding sources were Bureau of Justice Assistance Innovative Prosecution Program, Crocker Center for Civic Engagement, Montachusett Opportunity Council (MOC), ReImagine North of Main, Regional Economic Development Institute (REDI), Montachusett Regional Planning Commission (MRPC), City of Fitchburg, Lloyd G. Balfour Foundation, Community Foundation of North Central Massachusetts, Town of Winchendon, and Academic Affairs. Dr. Huang involved nearly fifty students in these grant projects. She and her students performed GPS surveys on hiking trails, neighborhoods, and industrial and commercial properties, conducted community-based spatial analysis, created traditional and web maps, and delivered comprehensive GIS research projects to serve the local communities.

Ms. Tina Morin, a full-time non-tenure track instructor, teaches *Astronomy* and *General Physics I and II*.

Dr. Reid Parsons, a geologist who specializes in planetary science, joined the faculty in Fall 2013. His primary teaching responsibilities include *Geology*, *Environmental Geology*, *Geomorphology*, *Planetary Science*, and *Remote Sensing*. He, along with Dr. Gordon, rotate the teaching of the *Honors Seminar in Environmental Science*, and with the department's upper level *Geographic Perspectives on Conservation*.

Dr. Parsons completed a two year appointment as a research professor at the University of Tokyo from 2017-2019, where he split his time between conducting original research and curating exhibits at the "TeNQ" space museum. Dr. Parsons is continuing his research on recent climate change on Mars as a Co-I on a NASA grant during the Spring and Summer of 2020 and will involve several undergraduate students as research assistants on the project. Dr. Parsons has maintained NASA research funding throughout his career at Fitchburg (starting in Fall of 2013) and has involved six current or former students on two grant-funded projects. Since 2016 he has published four papers (three as first author) in peer-reviewed journals, given seven professional conference presentations (three as an invited speaker), served on a NASA grant selection panel, and as a peer reviewer for three manuscripts submitted to the International Journal of Glaciology.

Dr. Jiang Yu, a physicist, joined the faculty in Fall 1996. She teaches introductory physics courses and offers directed study to students for upper level courses. As a College Board endorsed physics workshop consultant for more than 15 years, Jiang has each year led multiple one- or two-day workshops during the school year as well as several Advanced Placement Summer Institutes for high school physics teachers in Massachusetts and nationwide. In September 2018 and February 2019, Dr. Yu worked with the Plymouth (MA) Public Schools to provide training for their AP Physics teachers. Dr. Yu is a College Board's AP Physics Curriculum Adviser and Senior Auditor for the Board's AP Physics Syllabi Audit program. Dr. Yu recently served on the AP Physics Audit Scoring Standard Setting Committee from July

2018 to March 2020. In the past, she served a full term as a Chief Reader in the AP Physics Reading from 2009 to 2013, and a full term of Associated Chief Reader from 2013 to 2017.

2.1.3. Staff

Our department is supported by a shared administrative assistant (shared with Biology/Chemistry), **Ms. Lindsey Babineau**. She is responsible for daily administrative operations, which includes interfacing with students, faculty, staff, and external constituents. She manages the departmental budget, initiating and tracking purchases as well as running financial reports. Ms. Babineau is responsible for entering the departmental course schedule each year, and assisting with edits to the schedule each semester. She assists with a range of other occasional tasks, from assisting the department chair with scheduling rooms and catering for special events to maintenance of the departmental website.

Mr. Ian Murray is the laboratory technician for our department. His primary appointment is in the Biology/Chemistry department, where he serves as a lab technician for Chemistry and assists with Environmental Health and Safety. Approximately 40% of his time is devoted to Earth and Geographic Sciences, with most of his efforts focused on assisting Physics faculty on lab preparation and set up. He assists with ordering laboratory supplies, obtaining quotes for necessary items and communicating with the administrative assistant regarding the purchase of lab supplies. Although not formally in his job description, Mr. Murray often assists faculty with research equipment purchases and construction.

2.1.4. Resources

2.1.4.1. Financial

The department's fiscal annual budget, detailed in Appendix G, covers expenses for all of our programs and has varied from $9500 in 2015, decreasing to $9025 in 2020 owing to budget cuts across the University. In addition to the operational budget, each department is awarded travel funds from the administration: $400 per FT faculty member 2015-2019; budget cuts resulted in a reduction to $380 per faculty member in 2020. The department is typically awarded funds for one work study student each year. We often request additional strategic funds for extraordinary expenses such as large equipment purchases. Faculty have the opportunity to apply for internal grants to support professional development activities and to supplement travel expenses. We have also benefited from external grant support in recent years.

2.1.4.2. Space

The department has two dedicated classrooms for Earth Science lab courses: SCI120 (the "wet" lab) and 124 (the "dry" lab); the room between those two (SCI122) is the preparation area for those labs. Our computer lab, SCI127, is intended for courses that require computer access, including GIS-based courses, Remote Sensing, and Astronomy. Other lab courses, such as Geology, Meteorology, and Oceanography, make use of the computer lab for instruction with spreadsheet and graphing applications. The server to which those computers connect contains industry-standard software, including ArcGIS, ArcPro, and ENVI. The Information Technology office on campus provides exceptional support for our computer applications.

Physics instruction takes place in SCI 350, 339 and 242. Laboratory and demonstration equipment is stored in the prep rooms adjoining the classrooms (348, 337 and 240, respectively) and in the physics

storage room, 316. Additional storage space for the department as a whole is in 125, with specialized spaces for Electronics (126) and the 'Dirty Rock' room (SCI128), which houses our rock tumbler. Our department has shared access to the field/mud room, SCI131.

The department has three research spaces: SCI129 is the aquatic geochemistry lab, shared between Drs. Clark and Gordon; SCI317 is the geospatial research lab, shared between Drs. Huang and Parsons; and SCI319 is designed as a physics research space, currently in use for geospatial research.

All full-time faculty members have their own offices on the second and third floors of the Science building. The department chair office is located in SCI220, which is a suite of two offices (one for the EGS Department chair and one for the Biology/Chemistry Department chair) along with the shared administrative assistant. There is one departmental adjunct office that is shared by two or three Physics adjuncts per semester, and one shared (with Biology/Chemistry) adjunct office with six desks.

The department maintains a "Resource Room" (SCI118) for students. The room contains a couple of tables with chairs so that students can meet there to study. Faculty have donated geoscience and physics textbooks to the Resource Room for student use as well.

2.1.4.3. Equipment

The department maintains geoscience and physics equipment for both teaching and research (Appendix H).

2.2. Program processes

2.2.1. Curriculum

2.2.1.1 Curriculum development

Curriculum development in the department is generally initiated by a faculty member, informed by discipline trends and areas of expertise. For instance, Dr. Huang has developed two new GIS courses since the previous self study to keep pace with technology trends: WebGIS and GISII, the latter of which focuses on ArcPro. Similarly, Dr. Clark has developed two new courses to address curriculum gaps and that tie to her areas of expertise, one focused on water resources and one on soils. Dr. Gordon developed a course on Biogeochemistry, which is her area of expertise.

To offer a new course, it common practice for a faculty member to offer a course once or twice as a 'topics' course, after discussion with the curriculum committee and approval by the Department Chair and Health and Natural Sciences (HNS) Dean. If there is enough interest in the course from students and support from the department, the faculty member proposes the course for formal addition, first by approval through the department's curriculum committee and then through the University's governance process. The inclusion of new courses in the curriculum undergoes the same approval process.

2.2.1.2. Curriculum deployment

To meet the needs of students to navigate the required Environmental and Earth Science curriculum as outlined in section 1.4, the following is suggested as a four year plan.

	Fall	Spring
Year 1	Writing I Earth Systems Science Precalculus LAS electives	Writing II Geology Applied Statistics LAS electives
Year 2	General Chemistry I Intro to Geospatial Technology Oceanography LAS electives	General Chemistry II GIS Major elective LAS electives
Year 3	Ecology Remote Sensing Major elective LAS and free electives	Physics I Climatology Major elective LAS and free electives
Year 4	Physics II Hydrogeology Free electives	Geomorphology Free electives

To ensure that students are able to meet program requirements in a timely manner (ideally four years), we schedule courses on the following two year rotation:

Year	Fall	Spring
Every semester	Earth Systems or Env Geol Geology Intro to Geospatial Tech Oceanography	Earth Systems or Env Geol Geology Intro to Geospatial Tech Oceanography
Yearly	WebGIS/GIS II Meteorology	GIS Gen Bio II
Even-odd	Remote Sensing* Climate Change & Human Hist	Geomorphology* Geog Persp on Conservation
Odd-even	Hydrogeology*	Climatology* Conservation Bio

Required courses are shown in red. ***Required upper division courses to be offered yearly beginning AY21, as enrollments allow**.*

2.2.1.3. Internships

Lacking an internship coordinator and a formal internship program, opportunities arise either when a community member reaches out to a faculty member or when a student identifies an opportunity themselves. Dr. Huang has developed many community partnerships over the past fourteen years, so it is common for a city or local organization to contact her when they have a GIS need. Dr. Huang will then recruit students who, based on her evaluation of their skills, best match the needs of the internship site. Once a student is ready to pursue an internship, they must submit paperwork to the department (if they are seeking credit) that must be approved by the HNS Dean. The department adheres to the University's Internship policy[3], in that the faculty supervisor must perform at least one site visit during

[3] https://catalog.fitchburgstate.edu/content.php?catoid=36&navoid=2283#Internship_Policy

the internship period and communicate with the site supervisor regarding student performance and progress. The site supervisor submits a mid-term and final evaluation, and the student must complete both a written and oral report on their internship results and experience. The department currently lacks a more formal assessment process for internships beyond these evaluations. A list of recent internship experiences can be found in Appendix E.

2.2.2. Student learning and supports

Our students range from very strong academically to those who arrive on campus underprepared for college level work. The students who transfer into our program from other majors often do so because they could not maintain a required GPA or other progress metric in their original major. (The Organic Chemistry requirement in Biology is the best recruiting tool that our department has.) Our students often struggle with mathematics more than the geoscience content itself. Faculty have taken various approaches to address the quantitative deficiencies of all of our students, both general education and those within our majors. As an example, faculty have introduced math tutorials that are specifically designed for quantitative reasoning embedded in geoscience courses[4]. We have a strong collaboration with the mathematics department and have begun discussion about embedding their prepared pre-calculus modules into our courses, particularly physics. The tutor center offers free academic assistance for students, though it is notoriously difficult to find physics tutors since many students wait until their junior or senior years to complete physics.

STEM faculty recognize the difficulties faced by our student population in science and mathematics courses. Several faculty – up to 15 per semester – have participated in a faculty-led initiative to hold 'open office hours', during which any student can seek assistance with any STEM course by any participating faculty member. This initiative ran for three academic years – AY17-19 - with strong faculty support. It is likely to resume in Fall 2020.

We have begun embedding peer tutors into various courses, as described in section 2.2.1. We would like to expand the use of peer educators in courses such as physics.

As a small department, faculty are able to develop strong relationships with students and most faculty have adopted strategies that would be characterized as 'intensive advising'. We consistently discuss student challenges as a department and collaborate on potential solutions. Despite this, we recognize the need to host more community building events within the department, and are developing plans to do so beginning Fall 2020.

2.2.3. Faculty

2.2.3.1. Teaching responsibilities

Faculty have shared responsibility for teaching introductory courses and often take primary responsibility for upper division courses. Teaching responsibilities are detailed in Appendix F.

2.2.3.2. Advising responsibilities

[4] https://serc.carleton.edu/mathyouneed/index.html

Advising for our students is shared among faculty in the department. Most of the Geographic Science and Technology students are advised by Dr. Huang, while the Environmental and Earth Science students are advised by Drs. Clark, Gordon, Parsons, and Ms. Morin. Drs. Gordon and Huang share in the advising of Environmental Public Health majors.

2.2.3.3. Faculty retention

The University has a formal new faculty mentoring program, which is designed to address faculty retention. New faculty are assigned faculty mentors through this program and participate in workshops throughout their first focused on topics such as advising. As a collegial department, we work to ensure that new faculty have the resources that they need. We have retained all of our faculty members through retirement for the past 20+ years.

2.3. Program outcomes

2.3.1. Student learning outcomes

The following section is taken from the Environmental and Earth Science Assessment Plan, which is included in full as Appendix A.

Students who complete a major in Environmental and Earth Science will demonstrate a scientific understanding of how the Earth operates as a system and how humans interact with their environment. They will be able to distinguish between science and non-science, back up arguments with quantitative evidence, communicate their ideas effectively, and explain the necessity and characteristics of an interdisciplinary approach to solving environmental problems.

1. Students will communicate scientific information through written, oral, and graphical expression with clarity, logical organization, and use of scientific evidence to support their ideas.
    1.1. Information literacy: locate, evaluate, and use relevant information effectively.
    1.2. Written communication
    1.3. Oral communication
    1.4. Graphical/visual

2. Students will use the scientific process, including experimental design, analysis and critical evaluation of information, and integration of evidence from relevant sources, in the context of environmental investigations.
    2.1. Gather, organize, interpret, and report scientific data in the context of environmental and earth science investigations.
    2.2. Critically and logically analyze competing ideas, and distinguish between scientific and non-scientific approaches to solving problems.
    2.3. Use common software (e.g., Excel) to organize and graphically present data.
    2.4. Conduct spatial analysis in a GIS environment
    2.5. Analyze an environmental issue using and processing remotely acquired imagery
    2.6. Describe ethical principles related to scientific inquiry and use of Earth's resources.

3. Students will discuss the structure and composition of Earth's interior, surface, and atmosphere, and explain what it means to consider Earth as a system.

3.1. Describe the structure and composition of Earth's interior, surface (lithosphere, hydrosphere), and atmosphere

3.2. Identify interactions among lithosphere, atmosphere, hydrosphere, and biosphere

3.3. Illustrate and describe energy transfer and element cycling in the Earth system, such as Earth's energy budget, atmospheric circulation, ocean circulation, and the carbon cycle.

3.4. Discuss constructional forces that have shaped Earth's surface (e.g., plate tectonics), theories and evidence of crustal movements, and the effects of crustal movements on Earth's landscape; erosional-depositional processes that change the earth's surface (e.g., weathering, erosion); and describe processes by which water moves on, above, and beneath Earth's surface

3.5 describe Earth's physical evolution through geologic time

4. Students will apply an interdisciplinary approach to analyze and propose solutions to environmental science problems.

4.1. Integrate principles of earth science, physics, chemistry, and biology to answer geoscience questions.

4.2. Apply mathematical principles to quantitatively interpret geoscience data.

5. Describe the complex interactions between humans and their environment, including geological hazards, air and water pollution, global environmental issues, and use and conservation of Earth's resources.

5.1. Discuss society's dependence on Earth resources, such as mineral, rock resources, soil, and water resources; fossil fuels.

5.2. Explain natural hazards related to earth system processes.

5.3. Evaluate the effect of human activity on Earth's natural processes (e.g., global warming, ozone depletion, air pollution, water pollution).

2.3.2. Assessment summary

<u>Communication skills (SLO 1)</u>

In AY15, students in GEOG4600 *Environmental Hydrogeology* were assessed on their written communication skills using the score on their final manuscript. The grade on the scientific manuscript, which averaged 75%, integrated a variety of skills such as information literacy, writing mechanics, and scientific analysis. We therefore decided that future assessment efforts should include a detailed examination of student performance in these areas separately. In AY18 (*Climatology*) and AY19 (*Geographic Perspectives on Conservation*), students were evaluated on written and visual (graphing) communication skills as well as information literacy. The instructor used a self-developed rubric, which contained separate criteria for the above mentioned skills, against each of the students' final papers. Assessment results indicated that more than half of the students demonstrated proper writing mechanics for scientific communication, including writing an effective abstract, and were able to use figures and tables effectively. The percentage of students demonstrating proficiency remains below target, however, so additional scientific writing practice is being worked into the curriculum. For example, students are being asked to submit abstracts as separate assignments so that they have specific instruction and feedback on doing so. The percentage of students demonstrating proficiency with regards to properly citing sources and using appropriate sources of information was relatively low, highlighting the need for additional instruction in information literacy. Some faculty incorporate library instruction into their courses to ensure that students are equipped to find, use, and cite scientific journals; faculty will discuss whether this practice should be widened across additional courses.

In AY15, students in *Planetary Atmospheres* were assessed on their oral communication skills. The majority of students demonstrated competency in this skill, with all students earning at least 80% on their presentation, with an average score of 92%. Overall the department is satisfied with the degree to which we have incorporated oral presentations into required courses; we will continue to assess this skill going forward.

Scientific inquiry (SLO 2)

In AY15 and AY19, students were assessed in their spatial analysis skills. Overall, all students demonstrate proficiency in GIS skills in their upper division GIS course, which is an improvement since our previous self study. This has likely been achieved by the addition of a prerequisite (GEOG2400 or GEOG3120), in which students begin working in the GIS environment. Perhaps more importantly, students learn the organization of data that is the foundation of GIS analysis. In addition to prerequisites, the department has begun incorporating peer educators into courses during the past three years. Having an additional person in the classroom to assist students in their GIS activities and troubleshooting technology problems has enabled increased support to students enrolled in the geospatial technology courses. We hope to be able to continue the practice of using peer educators for geospatial courses as it seems to have improved student success.

Faculty have noted through direct assessment and through informal observation that our students continue to need improvement with regards to their graphing skills. Additional exercises that require students to organize spreadsheets and create graphs are being introduced into our 2000-level lab courses in response to this concern.

Applied learning (SLO 4)

In AY19, students were assessed on the application of their learning to analyze a real world environmental science problem. Assessment was completed via a cumulative question on the GEOG4200 *Geomorphology* final exam. Results indicated that approximately 60% of the students made connections between the material covered in the course over the semester and applied that knowledge to analyze a real world scenario. This suggests that assignments in which students must analyze and synthesize course concepts and themes should be added, particularly in upper level courses. Faculty will also work to emphasize applicability of course material throughout the curriculum.

Human-environment interactions (SLO 5)

In AY15, students were evaluated on human-environment interactions via a hydrofracking position paper in GEOG4700 *Geographic Perspectives on Conservation*. The average score on the relevant section of the paper (describing the scientific background of hydrofracking and its role in our energy system) was 82%. No major shifts in teaching or the curriculum were considered as a result.

Although faculty regularly evaluate student learning on SLO3, which incorporates fundamental knowledge of earth's composition and how earth functions as a system, in their course-level assessments, no student artifacts were submitted for department-level assessment during the self study period. The department will focus on this outcome for assessment in the years ahead.

2.3.3. Other measures of student success

As noted previously, students engage in a variety of participatory experiences. Most of these students present their work as part of Fitchburg State's Undergraduate Research Conference. A list of presentations is included in Appendix E.

The University surveys alumni to gather information about post-graduate employment, education, and other activities. The response rate for alumni in our department has been very low (one response), so we are not able to reflect on alumni data at this time.

3. Analysis and action plan for the future

3.1. Strengths and opportunities to build on strengths

We are a relatively **small department**, and while that presents some drawbacks particularly related to faculty workload, we consider it a strength with regards to creating a supportive environment for our students. We currently have enough full-time faculty to cover both introductory and upper division courses in EES.

Faculty in the department **collaborate** closely with those in other departments in the School of Health and Natural Sciences, particularly Biology/Chemistry. We have also established academic collaborations with Engineering Technology, Computer Science, Criminal Justice, Business, and History.

We have many of the **resources** that we need to support our teaching and research. We have dedicated classrooms for our lab-based courses, with adequate equipment for students. Our computer lab contains industry-standard software for GIS and remote sensing applications, which prepares students for the workforce and graduate school. The Technology department on campus provides considerable support for our computing needs, and are very responsive when problems arise. We are fortunate to have hard-working staff who, despite their dual appointments, manage to support the needs of faculty and students in the department.

We have seen **enrollment** in the major nearly triple since the previous self study, which we attribute primarily to the name of the major. The increase in enrollment is encouraging particularly considering that enrollment at the college overall has been decreasing in recent years. Retention within the major is strong.

We have **awesome students**.

Our department is well-positioned to offer courses that **keep pace with emerging changes** in geospatial technology and recent trends toward 'big data' in the geosciences. Dr. Parsons is piloting a big data approach to an introductory earth science course in the Honors program during Spring 2020, and the department will consider adding such a course to its offerings in the next couple of years. Dr. Huang has developed new GIS courses, such as WebGIS, in the past few years to ensure that our students are trained in new and emerging geospatial technologies. Along those lines, the department is considering the purchase of a drone in order to train students on the use of such technology for environmental research.

Students have **experiential learning** opportunities through coursework, internships, and independent research. Dr. Jane Huang has single-handedly developed a wide network of community and government relationships that provide internships for our students. Both Drs. Huang and Parsons have successfully acquired external grant funding that includes monies for paid student research. Dr. Clark has been awarded internal grants to support student research, and along with Drs. Huang and Gordon, participated in the Fitchburg State Summer Research Collaborative.

In addition to the above, our courses include **field experiences** in which students build skills collecting data and visualizing earth science concepts. In *Geology*, local field trips give students an opportunity to observe Earth processes in action and make observations of rock outcrops that would be performed by a professional geologist. During the *Oceanography* field trip to Plum Island, students measure water salinity and temperature at several locations along an estuarine transect, and conduct observations of beach and marsh environments. In *Geomorphology*, students use survey equipment and stream morphology classification rubrics to survey a reach of stream near campus, which forms a component of their final project. In *Environmental Hydrogeology*, students measure stream discharge, calculate bankfull discharge, characterize the channel substrate and sediment composition, and infer channel stability and erodibility using various techniques.

Students engage in **course-based research** in several geospatial classes. In GIS courses, students design projects to ask and seek answers to geospatial questions. They collect relevant data, perform geospatial analysis using tools and functionalities in GIS programs, and present their findings at the end of the semester. *Remote Sensing* students similarly develop an environmental research question that they answer by analyzing and interpreting satellite imagery, culminating in the presentation of their results.

Students in our department have had the opportunity to participate in **internships and independent research projects** (Appendix E). Dr. Parsons has hired six students to conduct Mars Science research since 2014. Dr. Clark secured funding for one student to continue a research project titled, "The Effect of Road Salts on the Salinization of Freshwater Streams in the Fitchburg Area". Dr. Gordon has supervised several independent studies and internships. Dr. Huang has supervised twenty seven internship experiences for students in the past five years (Appendix E).

Faculty in our department are in the process of developing **study abroad** opportunities. Drs. Huang and Clark will offer *Geology and Environmental Mapping of Peru*, which includes a 10 day trip to Peru, during Spring 2022. Dr. Huang has been pursuing an academic partnership with a university in Lima for collaboration with the aim of eventually developing an exchange program. Future collaborations with other Fitchburg State study abroad programs, such as the *Tropical Ecology* offering in Costa Rica, are being discussed.

3.2. Areas of, and strategies for, improvement

Enrollments

While we are pleased with our enrollment trend overall, we continue to see low numbers of incoming freshman who declare EES as their major. We recognize the need for additional recruitment efforts.

Action: Increased recruitment of new students and initiatives to retain students

Timeline: The department plans to increase marketing of the major in our introductory courses, especially to align with the academic advising period, during the next academic year. To improve retention of current students, we will discuss expansion of the use of peer educators during AY21, and consider an eventual peer mentor program. Faculty will begin discussion with current students to visit the high schools from which they graduated, with the aim of a formalized program for doing so by AY23.

The EES major attracts 1-6 transfer students each year, which represents less than 1.5% of the transfer student population of the University. While this is a higher percentage compared to the incoming freshman class declaring an EES major, it represents an area in which the department could improve.

There are already some MassTransfer linked programs for the EES major, but others could be developed to encourage more students to enter our department upon transfer.

Action: Develop more MassTransfer linked programs and develop articulation agreements.

Timeline: The department chair will work with Heather Thomas, MassTransfer coordinator, to identify opportunities to expand the department's connection with local community colleges. The chair will also continue to foster relationships with similar departments at MWCC and QCC, which began during AY20.

Curriculum and assessment

The **general education** (LA&S) curriculum has recently gone through a revision, to take effect Fall 2021. Under the new LA&S, students have only one explicit science requirement - scientific inquiry and analysis (SI). Our lab-based courses will meet this requirement, but our courses that do not have an accompanying lab component may not. Courses such as *Earth Systems Science*, from which we often recruit students to the major, may no longer be a draw for non-majors. Technology-based courses similarly will not address the new SI requirement, but are likely to address the Procedural and Logical Thinking outcome.

Action: Modify courses as needed to address new outcomes

Timeline: EGS faculty will put courses through governance for LAS designation during AY21. The faculty will discuss ways to modify courses, either by adding a lab or otherwise emphasizing inquiry and analysis, for courses that have not traditionally had this focus.

The curriculum revision that accompanied the name of our major to Environmental and Earth Science repackaged existing courses that have an environmental focus. There are several **courses**, currently not on the books, that we consider important in an environmental science curriculum. In particular, the department has identified soils and water resources as central to environmental science, while courses on biogeochemistry and energy are desirable additions. We are therefore piloting courses in three of those areas, and plan to submit proposals to formally add those courses in the next few years. We would additionally like to add a field-based course in partnership with our Biology colleagues, and plan to continue discussions toward that end.

Action: Update curriculum and consider the addition of a field-based course

Timeline: Faculty will put through governance new courses during AY21 and 22, and update the Environmental and Earth Science curriculum to include those courses. At the same time, we will remove old courses that are no longer offered or deemed relevant. We will also discuss the logistics and demand for a field-based course during AY22.

As indicated in our assessment summary, there are some **key skills** that our students should further develop, such as information literacy and graphing.

Action: Examine the curriculum holistically to identify courses in which students are introduced to and further develop throughout the curriculum. Collaborate with the library and other departments (e.g., Mathematics) to support skill development and mastery.

Timeline: Faculty will connect key skills to the curriculum modifications discussed above during AY21, and foster relevant collaborations beginning AY22.

Along these lines, our assessment has been focused on required major courses, with less emphasis on formal assessment of LA&S courses and internships.

Action: Develop assessment tools for general education courses and internships.

Timeline: Discussion of general education outcomes for departmental courses will coincide with aligning courses with the new LA&S designations during AY21. Developing a robust assessment of internship experiences will occur during AY22 and 23.

Despite many opportunities for students to engage in experiential learning, our curriculum does not require a **capstone experience**. Enrollments in the past have not justified such a requirement, and there may not be enough internship sites to place all of our students. Most of the available internships require GIS skills, which limits those opportunities to students who have already progressed through two of their three technology courses. An additional challenge for a departmental internship requirement is that the University has an established minimum GPA (2.5) as part of the internship policy that some of our students may not meet. In recognition of the importance of a capstone experience, the department will explore options beyond a strict internship requirement, such as a capstone experience embedded within a required course. The technology-based 4000-level courses (GIS, GISII, WebGIS, and Remote Sensing) already require completion of a semester-long project. Faculty who teach *Environmental Hydrogeology* and *Geomorphology* plan to experiment with a semester-long project during the next offering of each course. The department will then reevaluate the best way to approach a capstone requirement.

Action: Consider the addition of a required capstone course.

Timeline: Faculty in the department are exploring various options to eventually require a capstone experience of all majors, particularly ones that develop traditional earth science skills. Discussions for a plan to accomplish this will take place during AY21, with an initial proof of concept employed during AY22 or AY23, depending on course enrollments.

While we see the shift to Environmental Earth Science as a positive direction for the department, particularly as it pertains to attracting, retaining, and preparing students for a variety of career paths, we recognize our curriculum no longer meets the need for students who seek a traditional geology pathway. The integration of geology-based capstone experiences may help to address this concern.

Action: Expand internship or independent study opportunities in traditional geology

Timeline: A designated faculty member will work with career services to identify local opportunities, beginning AY22.

Strengthening community

We do at times have an active student club, but the department lacks a consistent offering of extracurricular activities. We recognize the benefit of hosting regular social and outreach events as a means to develop a stronger sense of community for students in the department. We plan to work with students to support their efforts to maintain an active student club, but will also begin to organize more social and outreach events, such as local clean-ups, throughout the year.

Action: Organize monthly activities for both faculty and students

Timeline: Develop a plan for activities during fall 2020; hold at least two department events during spring 2021. Expand program in years that follow.

3.3. Resources to accomplish the plan

Some of the recommendations listed above will not require substantial resources. To achieve all of the above, additional resources include a new faculty hire, a ten-month administrative assistant, and additional support for research.

As noted in the previous external review, the department needs an additional geographer. Dr. Huang is the only full time geographer, and currently supervises most of the internships in the department. While we are able to cover all courses required for the Environmental and Earth Science major at this time, an additional geographer would support our department and the development of our students overall. As a small department, we are stretched in our efforts to participate in important initiatives on campus, such as the First Year Experience, the University Assessment Committee, and various governance committees while also providing participatory experiences for our students. An additional geographer would help support this work.

Our current administrative assistant is shared with Biology/Chemistry, which is a large enough department to warrant its own administrative assistant. The workload on our current admin is therefore in excess of most comparable staff members on campus. We submitted a request for a 10 month administrative assistant during the budgeting process for AY21 to support the work of the department.

Finally, to grow the offering of capstone experiences via internships or independent studies, additional support for research is needed. Faculty and students would benefit from both additional research funding as well as more opportunities for course release.

3.4. Action plan in table format

Specific area where improvement is needed	Evidence to support the recommended change	Person(s) responsible for implementing the change	Timeline for implementation	Resources needed	Assessment Plan
Enrollments	Enrollments, while improving, remain below target	All faculty	Begin AY21	May require small but undetermined amount of funding	Increased enrollments
Curriculum and assessment	New LA&S and associated assessment; Gaps in major courses; skill development; internship assessment	Geo faculty	AY21 – Overall discussion; LAS proposals and assessment plan AY22 – add/modify major courses as needed AY22-23 – discuss internship assessment AY24 - evaluate	None	Addition of key courses to curriculum; LAS designations for intro courses; continued assessment of skills; assessment plan for LA&S outcomes and internships
Capstone experience	No required capstone	Geo faculty	AY21 – planning AY22 – pilot of course-based capstone; identify earth science internships AY23 - evaluate	Course release to build internships	Addition of capstone experience to curriculum
Strengthen community	Limited sustained opportunities for student extracurricular engagement	All faculty	AY21 – planning AY22 – at least three events AY23 – monthly events	Not yet identified	Number of planned departmental events; attendance at said events

Appendix A. **Environmental and Earth Science Curriculum and Assessment**

I. Catalog description of major requirements

A BS or BA in Environmental and Earth Science require at least 36 credit hours. Required courses include:

Core requirements (27 credits):

GEOG 1000 - Earth Systems Science 3 cr. Or ENSC 1000 - Introduction to Environmental Science 3 cr.
GEOG 2100 - Geology 3 cr.
GEOG 2400 - Introduction to Geospatial Technologies 3 cr. Or GEOG 3120 - Computer Cartography 3 cr.
GEOG 2500 - Oceanography 3 cr.
GEOG 3110 - Climatology 3 cr.
GEOG 4000 - Geographic Information System 3 cr. Or GEOG4002 GIS II or GEOG 4001 WebGIS
GEOG 4200 - Geomorphology 3 cr.
GEOG 4500 - Remote Sensing of the Environment 3 cr.
GEOG 4600 - Environmental Hydrogeology 3 cr.

An additional three courses chosen from (9 credits):
BIOL 1900 - General Biology II 4 cr. Or BIOL 2100 - Flora of New England 3 cr. Or BIOL 3100 - Conservation Biology 3 cr. or BIOL 3102 - Marine Biology 3 cr.
ENSC 2000 - Field Techniques in Environmental Science I 3 cr.
GEOG 2056 - Climate Change and Human History 3 cr.
GEOG 2200 - Meteorology 3 cr.
GEOG 2800 - Map Use 3 cr.
GEOG 3270 - Common Rocks and Minerals 3 cr.
GEOG 4220 - Structural Geology 3 cr.
GEOG 4700 - Geographic Perspectives on Conservation 3 cr.
GEOG 4900 - Independent Study in Geography 1, 2, 3 cr.
GEOG 4940 - Internship in Geography 3 cr. * or GEOG 4950 - Internship in Geography 6 cr. * or GEOG 4960 - Internship in Geography 12 cr. *
*(max 9 cr of internship to apply toward major)

Required cognate courses (27 cr): (to be taken as part of Liberal Arts and Sciences distribution and free electives):
BIOL 2300 - Ecology 4 cr.
CHEM 1300 - General Chemistry I 4 cr.
CHEM 1400 - General Chemistry II 4 cr.
MATH 1700 - Applied Statistics 3 cr.
MATH 1300 - Precalculus 4 cr. or MATH 2300 - Calculus I 4 cr.
PHYS 2300 - General Physics I 4 cr. or PHYS 2600 - Calculus-Based Physics I 4 cr.
PHYS 2400 - General Physics II 4 cr. or PHYS 2700 - Calculus-Based Physics II 4 cr.

II. Assessment Plan

Students who complete a major in Environmental and Earth Science will demonstrate a scientific understanding of how the Earth operates as a system and how humans interact with their environment. They will be able to distinguish between science and non-science, back up arguments with quantitative evidence, communicate their ideas effectively, and explain the necessity and characteristics of an interdisciplinary approach to solving environmental problems.

Environmental and earth science students will:

- communicate scientific information through written, oral, and graphical expression with clarity, logical organization, and use of scientific evidence to support their ideas.
- use the scientific process, including experimental design, analysis and critical evaluation of information, and integration of evidence from relevant sources, in the context of environmental investigations.
- discuss the structure and composition of Earth's interior, surface, and atmosphere, and explain what it means to consider Earth as a system.
- apply an interdisciplinary approach to analyze and propose solutions to environmental science problems.
- describe the complex interactions between humans and their environment, including geological hazards, air and water pollution, global environmental issues, and use and conservation of Earth's resources.

1. Students will communicate scientific information through written, oral, and graphical expression with clarity, logical organization, and use of scientific evidence to support their ideas.

1.1. Information literacy: locate, evaluate, and use relevant information effectively.
1.2. Written communication
1.3. Oral communication
1.4. Graphical/visual

2. Students will use the scientific process, including experimental design, analysis and critical evaluation of information, and integration of evidence from relevant sources, in the context of environmental investigations.

2.1. Gather, organize, interpret, and report scientific data in the context of environmental and earth science investigations.
2.2. Critically and logically analyze competing ideas, and distinguish between scientific and non-scientific approaches to solving problems.
2.3. Use common software (e.g., Excel) to organize and graphically present data.
2.4. Conduct spatial analysis in a GIS environment
2.5. Analyze an environmental issue using and processing remotely acquired imagery
2.6. Describe ethical principles related to scientific inquiry and use of Earth's resources.

3. Students will discuss the structure and composition of Earth's interior, surface, and atmosphere, and explain what it means to consider Earth as a system.

3.1. Describe the structure and composition of Earth's interior, surface (lithosphere, hydrosphere), and atmosphere
3.2. Identify interactions among lithosphere, atmosphere, hydrosphere, and biosphere
3.3. Illustrate and describe energy transfer and element cycling in the Earth system, such as Earth's energy budget, atmospheric circulation, ocean circulation, and the carbon cycle.

3.4. Discuss constructional forces that have shaped Earth's surface (e.g., plate tectonics), theories and evidence of crustal movements, and the effects of crustal movements on Earth's landscape; erosional-depositional processes that change the earth's surface (e.g., weathering, erosion); and describe processes by which water moves on, above, and beneath Earth's surface

3.5 describe Earth's physical evolution through geologic time

4. Students will apply an interdisciplinary approach to analyze and propose solutions to environmental science problems.

4.1. Integrate principles of earth science, physics, chemistry, and biology to answer geoscience questions.

4.2. Apply mathematical principles to quantitatively interpret geoscience data.

5. Describe the complex interactions between humans and their environment, including geological hazards, air and water pollution, global environmental issues, and use and conservation of Earth's resources.

5.1. Discuss society's dependence on Earth resources, such as mineral, rock resources, soil, and water resources; fossil fuels.

5.2. Explain natural hazards related to earth system processes.

5.3. Evaluate the effect of human activity on Earth's natural processes (e.g., global warming, ozone depletion, air pollution, water pollution).

The curriculum to achieve these objectives is as follows:

To gain content knowledge in the **physical environment**, students will take six courses (18 credits):
GEOG1000 *Earth Systems Science,* **OR** ENVS1000 *Introduction to Environmental Science* (3) OR
GEOG2003 *Environmental Geology*
GEOG2100 *Geology* (3)
GEOG2500 *Oceanography* (3)
GEOG3110 *Climatology* (3)
GEOG4200 *Geomorphology* (3)
GEOG4600 *Environmental Hydrogeology*

To develop skills in **environmental spatial analysis**, students will take three courses (9 credits)
GEOG2400 *Introduction to Geospatial Technologies* OR GEOG3120 *Computer Cartography* (3)
GEOG4000 *GIS* (3)
GEOG4500 *Remote Sensing of the Environment* (3)

To understand **environmental interactions and applications** – students choose three courses (9 credits) from the following:
GEOG2200 *Meteorology*
GEOG2056 *Climate Change and Human History*
GEOG4220 *Structural Geology*
GEOG4700 *Geographic Perspectives on Conservation*
GEOG4900 Independent Study in Geo
GEOG4940/50/60 Internship in Geo
BIOL2100 *Flora of New England* OR BIOL3100 *Conservation Biology* OR BIOL3102 *Marine Biology*
ENSC2000 *Field Techniques in Environmental Science*
ENSC4050 *Internship in Environmental Science*

Required cognate courses allow students to integrate knowledge from various fields to address environmental problems:
Physics I and II
General Chemistry I and II
MATH1700
MATH1300 or 2300
BIOL2300 *Ecology*

Assessment plan, continued: Curriculum map, aligning outcomes with required and elective courses.

Courses-->	1000 *OR*	2003	2100	2400	2500	3110	400X	4200	4500	4600		2056	2200	4220	4700	4900
SLO	EES	Evn Geo	Geol	Geospatial	Ocean	Climo	GIS	Geomorph	Rem Sens	Hydro		CCHH	Meteorolog	structural	eog Pers Co	Internship
1. Students will communicate scientific information through written, oral, and graphical expression with clarity, logical organization, and use of scientific evidence to support their ideas.																
1.1. Information literacy						x						x				
1.2. written communication			x		x	x		x		x		x				x
1.3. oral communication						x	x	x	x	x					x	x
1.4. graph/visual				x	x	x	x	x	x	x			x			
2. Students will use the scientific process, including experimental design, analysis and critical evaluation of information, and integration of evidence from relevant sources, in the context of environmental investigations.																
2.1. Gather, organize, interpret, and report scientific data in the context of environmental and earth science investigations				x	x		x	x	x	x			x			x
2.2. Critically and logically analyze competing ideas, and distinguish between scientific and non-scientific approaches to solving problems																
2.3. Use common software (e.g., Excel) to organize and graphically present data					x	x							x			
2.4. Conduct spatial analysis in a GIS environment							x									
2.5. Analyze an environmental issue using and processing remotely acquired imagery									x							
2.6. Describe ethical principles related to scientific inquiry and use of Earth's resources.															x	
3. Students will discuss the structure and composition of Earth's interior, surface, and atmosphere, and explain what it means to consider Earth as a system.																
3.1. Describe the structure and composition of Earth's interior, surface (lithosphere, hydrosphere), and atmosphere.	x	x	x		x	x		x		x			x			
3.2. Identify interactions among lithosphere, atmosphere, hydrosphere, and biosphere	x	x			x	x							x		x	
3.3. Illustrate and describe energy transfer and element cycling in the Earth system, such as Earth's energy budget, atmospheric circulation, ocean circulation, and the carbon cycle.	x	x			x	x							x			
3.4. Discuss constructional forces that have shaped Earth's surface (e.g., plate tectonics), theories and evidence of crustal movements, and the effects of crustal movements on Earth's landscape; erosional-depositional processes that change the earth's surface (e.g., weathering, erosion); and describe processes by which water moves on, above, and beneath Earth's surface.	x	x	x		x			x		x						
3.5. describe Earth's physical evolution through geologic time						x										varies
4. Students will apply an interdisciplinary approach to analyze and propose solutions to environmental science problems.																
4.1. Integrate principles of earth science, physics, chemistry, and biology to answer geoscience questions.		x				x		x	x	x					x	
4.2. Apply mathematical principles to quantitatively interpret geoscience data.	x	x	x	x	x	x	x	x	x	x			x		x	
5. Describe the complex interactions between humans and their environment, including geological hazards, air and water pollution, global environmental issues, and use and conservation of Earth's resources.																
5.1. Discuss society's dependence on Earth resources, such as mineral, rock resources, soil, and water resources; fossil fuels.		x								x					x	
5.2. Explain natural hazards related to earth system processes		x	x							x			x			
5.3. Evaluate the effect of human activity on Earth's natural processes (e.g., global warming, ozone depletion, air pollution, water pollution)	x	x			x	x						x	x		x	

Assessment plan, continued: Assessment process

PLO #	PLO	Frequency of assessment	Assessment tool	Process (who performs assessment, analyzes data)
1.	Students will communicate scientific information through written, oral, and graphical expression with clarity, logical organization, and use of scientific evidence to support their ideas.	Annual	Manuscripts Presentations Student-created graphs Student-created maps	Instructor uses rubric to assess
2.	Students will use the scientific process, including experimental design, analysis and critical evaluation of information, and integration of evidence from relevant sources, in the context of environmental investigations.	Every 2-3y	Lab reports	Instructor
3.	Students will discuss the structure and composition of Earth's interior, surface, and atmosphere, and explain what it means to consider Earth as a system.	Annual	Exam question in relevant course	Instructor grades question
4.	Students will apply an interdisciplinary approach to analyze and propose solutions to environmental science problems.	Every 2-3y	Exam question in relevant course; Paper	Instructor grades question/essay
5.	Students will describe the complex interactions between humans and their environment, including geological hazards, air and water pollution, global environmental issues, and use and conservation of Earth's resources.	Every 2-3y	Exam question in relevant course; Position paper	Instructor grades question/essay

Appendix B. **Enrollment in Earth and Geographic Sciences**

Earth & Geographic Sciences Departmental Trend Data								
Day-School								
	AY 13	AY 14	AY 15	AY 16	AY 17	AY 18	AY 19	Trend
Total Enrollment in Earth & Geographic Sciences classes	**726**	**791**	**736**	**723**	**769**	**808**	**846**	
Total Enrollment in All Classes	32,683	33,952	34,081	34,062	34,169	34,257	33,695	
Percentage of total enrollment: Earth & Geographic Sciences classes	**2.22%**	**2.33%**	**2.16%**	**2.12%**	**2.25%**	**2.36%**	**2.51%**	
Graduates in the Major	**5**	**5**	**6**	**2**	**4**	**11**	**8**	
Percentage of overall graduates	**0.64%**	**0.62%**	**0.83%**	**0.27%**	**0.51%**	**1.46%**	**1.09%**	
Environmental & Earth Science, B.S.	3	4	5	1	1	8	6	
Geographic Science & Technology, B.S.	2	1	1	1	3	3	2	
Graduates in the Minor								
Earth Science Minor	5	2	3	2	3	4	0	
Geographic Information Systems Minor	3	1	4	1	2	4	5	
Geographic Science and Technology	0	0	0	0	0	4		
Number of Majors[2]	**16**	**24**	**30**	**30**	**40**	**48**	**47**	
Overall declared majors[3]	3,748	3,824	3,806	3,840	3,862	3,837	3,805	
Percentage of overall declared majors	**0.43%**	**0.63%**	**0.79%**	**0.78%**	**1.04%**	**1.25%**	**1.24%**	
Environmental & Earth Science, B.A.	0	0	0	0	0	1	0	
Environmental & Earth Science, B.S.	13	18	21	21	28	36	37	
Geographic Science & Technology, B.A.	0	0	0	0	0	0	0	
Geographic Science & Technology, B.S.	3	6	9	9	12	11	10	
Number of incoming freshmen majors	1	5	4	4	3	4	4	
Percentage of incoming freshmen class[4]	0.14%	0.65%	0.59%	0.55%	0.42%	0.54%	0.56%	
Number of incoming transfer majors	5	2	7	4	6	7	6	
Percentage of incoming transfer class[4]	1.26%	0.46%	1.67%	1.02%	1.36%	1.62%	1.44%	
Number of Minors								
ERTH Earth Science	11	5	8	8	12	8	6	
GIS Geographic Information Systems	0	0	0	9	5	11	7	
GEOE Geographic Science & Technology	11	7	8	6	14	12	8	
Retention Rates[5]								
Retention Rate in Major - Earth & Geographic Sciences	-	0.00%	50.00%	75.00%	100.00%	0.00%	50.00%	
Retention Rate Changed Major - Earth & Geographic Sciences	-	100.00%	16.67%	0.00%	0.00%	66.67%	0.00%	
Retention Rate in Major Institutional	57.91%	62.52%	62.15%	58.75%	62.36%	65.17%	61.38%	
Retention Rate Changed Major Institutional	16.11%	15.56%	15.19%	16.11%	12.55%	12.80%	11.98%	

[1] *Academic Year* covers the fall and spring semesters ending with the spring term of the academic year date (ex. Fall, 2018 and Spring, 2019 = AY19)

[2] *Number of Majors* for this department includes both major 1 and major 2.

[3] Number *Overall Declared Majors* is the number of matriculated undergraduate day-school students, excluding Pre-majors.

[4] *Incoming freshmen/Incoming transfers as percentage of incoming class*

[5] Academic year indicated for *Retention Rates* is the year for which students were retained.

Retention Rates is calculation for full-time freshmen entering in fall and retained for the following fall semester.

Appendix C. **Courses that satisfy general education requirements offered by the Earth and Geographic Sciences Department**

Designation codes are as follows: SMT – Science, Math, and Technology; CTW – Citizenship and the World; GDCN – Global Diversity, non-western

GEOG 1000 Earth Systems Science - SMT
GEOG 1100 Principles of Human Geography - CTW, GDCN
GEOG1300 Earth, Sea, and Air – SMT, Lab
GEOG2003 Environmental Geology - SMT
GEOG 2056 Climate Change and Human History – SMT
GEOG2100 Geology - SMT, Lab
GEOG 2200 Meteorology - SMT, Lab
GEOG 2400 Introduction to Geospatial Technologies- SMT
GEOG 2500 Oceanography - SMT, Lab
GEOG 2800 Map Use – SMT
GEOG 3110 Climatology- SMT
GEOG 3120 Computer Cartography- SMT
GEOG 3300 Urban Geography CTW, GDCN
GEOG 3400 Population Geography- CTW, GDCN
GEOG 4000 Geographic Information Systems – SMT
PHYS 1100 Physical Science - SMT, Lab
GEOG/PHYS 2000 Astronomy- SMT, Lab
PHYS 2300 General Physics I - SMT, Lab
PHYS 2400 General Physics II - SMT, Lab
PHYS 2600 Calculus-Based Physics I - SMT, Lab
PHYS 2700 Calculus-Based Physics II - SMT, Lab

Appendix D. **Environmental and Earth Science student demographic and graduation data, AY14-18.**

Students by Gender and Race/Ethnicity
Environmental and Earth Science

	AY 14			AY 15			AY 16			AY 17			AY 18		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
American Indian or Alaskan Native	**0**	**0**	**0**	0	0	**0**	0	0	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Asian	0	1	**1**	0	0	**0**	0	0	**0**	1	0	**1**	2	0	**2**
Black or African American	0	0	**0**	0	0	**0**	0	1	**1**	0	1	**1**	0	1	**1**
Hispanic	0	1	**1**	1	1	**2**	1	0	**1**	2	0	**2**	1	1	**2**
More than one	0	0	**0**	0	1	**1**	1	0	**1**	0	0	**0**	0	0	**0**
awaiian or Pacific Islander	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
Unknown	0	0	**0**	1	0	**1**	0	0	**0**	1	0	**1**	2	0	**2**
White	10	6	**16**	8	9	**17**	7	11	**18**	10	13	**23**	14	16	**30**
Total	**10**	**8**	**18**	**10**	**11**	**21**	**9**	**12**	**21**	**14**	**14**	**28**	**19**	**18**	**37**

	4-Year EART	**4-Year Changed**	**4-Year Overall**	**6-Year EART**	**6-Year Chganged**	**6-Year Overall**
Academic Year (Entering fall term)						
2010	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2011	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2012	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%
2013	0.00%	50.00%	50.00%	NA	NA	NA
2014	100.00%	0.00%	100.00%	NA	NA	NA

	Four-Year	**4-Year Major**	**4-Year Changed**
Institutional four-year graduation rate:			
(Last five available years)	37.06%	28.64%	8.42%

	Six-Year	**6-Year Major**	**6-Year Changed**
Institutional six-year graduation rate:			
(Last three available year	58.59%	44.11%	14.47%

Average Years To Graduate:
(Students graduating within six years)

Entering Cohort Year				
2008	**2009**	**2010**	**2011**	**2012**
4.25	NA	4.00	NA	4.00
Institutional Average:	4.36	4.39	4.32	4.30	4.33

Appendix E. **Student participatory experiences, AY15-20.**

I. Internships

Semester	Student(s)	Major	Location/organization	Faculty supervisor
2015 SumII	Tristan Taylor	GST	North County Land Trust (NCLT)	Dr. Huang
2015 Fall	Tyler Godin	GST	Montachusett Regional Planning Commission (MRPC)	Dr. Huang
2015 Fall	Laura Leclerc	GST	NCLT	Dr. Huang
2015 Fall	Robin Pike	GST	Ayer DPW	Dr. Huang
2016 Spring	Sam Gallagher Kayla Kress	EES GST	On campus, North of Main	Dr. Huang
2016 Spring	Tyler Godin	GST	MRPC	Dr. Huang
2016 Spring	Robin Pike	GST	Ayer DPW	Dr. Huang
2016 Fall	Kayla Kress	GST	On campus, North of Main	Dr. Huang
2016 Fall	Jacob Hogue	EES	On campus, North of Main	Dr. Huang
2016 Fall	Tyler Godin Huy Vo	GST CS	MRPC	Dr. Huang
2017 Spring	Jacob Hogue Jake Glick	EES EES	On campus, North of Main	Dr. Huang
2017 Spring	Nick DePaula	GST	Fitchburg Water Dept	Dr. Huang
2017 Spring	Huy Vo	CS	Ayer DPW	Dr. Huang
2017 Fall	Ali Wertheim	EES	City of Gardner	Dr. Huang
2017 Fall	Victoria Leblanc	GST	NCLT	Dr. Huang
2017 Fall	Tim Maclaughlin Sean Beverly Jake Glick Tallie Foster	GST EES EES EES	On campus, North of Main	Dr. Huang
2017 Fall	Paige Harrington	EES	On campus, Environmental Health and Safety	Dr. Gordon
2018 Spring	Jon Barto	GST	City of Gardner	Dr. Huang
2018 Spring	Tim Maclaughlin	GST	On campus, web GIS platform	Dr. Huang
2018 SumII	Jace Peterson	EES	On campus, Sediment in the Nashua River	Dr. Gordon
2018 Fall	Sean Beverly	EES	On campus, 3D print of Nashua Watershed	Dr. Huang
2018 Fall	Jesse Corbin	GST	Trail survey and mapping for the Snow-Riders of Nashuaway)	Dr. Huang
2019 Spring	Caroline Anderson	EES	On campus, opioid project	Dr. Huang
2019 Spring	Ed Zink	GST	City of Leominster	Dr. Huang
2020 Spring	Russell Pearson	GST	On campus, opioid project	Dr. Huang
2020 Spring	Hannah Wilder	EES	New England Aquarium	Dr. Gordon

II. Independent Research projects

Semester	Student(s)	Major	Project	Faculty supervisor
Sum14	Jeff Liddle Dan Straitt	ESS	Survey of Ice Deposits East of Hellas Basin on Mars	Dr. Parsons
Sum15	Kayla Kress	GST	Topographic Characteristics of Mid-latitude Martian Ice Deposits	Dr. Parsons
Sum16	Jacob Hogue	EES	A Coupled Geophysical and Modeling Analysis of Mid-Latitude Glaciers on Mars	Dr. Parsons
Sum17	Sean Beverly	EES	Application of GIS in Assessing the Health of the Nashua River	Dr. Huang
Sum17	Kait Berube	EES	Sediment characteristics of the Nashua River	Dr. Gordon
Sum17	Nick DePaula	GST	Studying Public Health in Fitchburg Using GIS	Dr. Huang
Sum17	Tallie Foster	EES	Sediment characteristics of the Nashua River	Dr. Gordon
Sum17	Jacob Hogue	EES	Application of GIS in Assessing the Health of the Nashua River	Dr. Huang
Sum17	Tim McLaughlin	GST	Studying Public Health in Fitchburg Using GIS	Dr. Huang
F17-Sp19	Tomohiro Kanzaki Yuki Suenaga	Univ. Tokyo	Moraine Formation on the Tharsis Montes, Mars Toward Automated Change Detection in Mars Orbital Imagery	Dr. Parsons
Sum18	Caroline Anderson	EES	Simulations of the Nashua River Flooding in Fitchburg	Dr. Huang
Sum18	Sam Gallagher	EES	The Analysis of the Land Use and Land Cover of the Nashua River Watershed	Dr. Huang
Sum18	Samantha Richard	EES	Microplastics in the Nashua River watershed	Dr. Gordon
Sum19	Maeve Ahern	EES	Microplastics in tributaries of the Nashua River	Dr. Gordon
Sum19	Courtney Aulden	EES	Flood Simulating and Web Mapping of the Nashua River Watershed	Dr. Huang
Sum19	Alina Salaiz	EES	Hydrogeomorphology of the Nashua River tributaries	Dr. Clark
Sum19	Teigan Weismann	EES	Hydrogeomorphology of the Nashua River tributaries	Dr. Clark
Sp20	Alina Salaiz	EES	The Effects of Road Salt on the Salinization of Freshwater Streams in the Fitchburg Area	Dr. Clark
Sp20	Fernanda Munari Sam Phelps	EES GST	Change Detection on Mars using Principal Component Analysis	Dr. Parsons

III. Peer educator experiences

Semester	Student	Major	Course
Fall 2018	Devin Richardt	EES	Meteorology
Spring 2019	Sean Beverly	EES	Geographic Information Systems
Spring 2019	Sam Gallagher	EES	Oceanography, Intro to Geospatial Technology
Spring 2020	Sam Phelps	GST	Intro to Geospatial technology; Urban Geography; GIS

IV. EGS student presentations at Fitchburg State's Undergraduate Research Conference, 2015-2019.

Presentations are listed by student author(s), with the supervising faculty shown in parentheses.

2015

Robin Pike, Laura Leclerc, Tristan Taylor (Huang). Inventorying Farmland with the North County Land Trust Using GIS

Henry Mros (Huang). Predicting New England Bound Hurricane by Offshore Location

Nick DePaula (Huang). GIS Internship with the Fitchburg Wastewater Department

2016

Robin Pike (Huang). GIS Internship with the Ayer Department of Public Works

Devin Richardt, Gary Van Bramer, Jacob Hogue (Huang). GPS Survey of Healthy-Heart Trails – A Service Learning Term Project of GEOG 2400

Sam Gallagher and Kayla Kress (Huang). Neighborhood Property Mapping and Analysis using GIS

Tyler Godin (Huang). Transportation Geography Internship with Montachusett Regional Planning Commission

Laura Leclerc and Tristan Taylor (Huang). Land Conservation and GIS Internships with North County Land Trust

2017

Jacob Hogue and Jake Glick (Huang). GIS Mapping and Analysis for the Reimagine North of Main project

Huy Vo (Huang). GIS Internships with MRPC and Ayer DPW

Paige Harrington and Jacob Hogue (Parsons). Electricity and Waste: Understanding Sustainability on Fitchburg State's Campus

Paige Harrington (Gordon). The Effects of Climate Change on the Amazon Rainforest

Tallie Foster (Gordon). Climate Change in the Pacific Northwest

Vanessa Kahn (Gordon). Climate Change in the Great Barrier Reef

Samuel Gallagher (Gordon). The Effects of Climate Change on the Philippines

2018

Sean Beverly and Jacob Hogue (Huang). Application of Geographic Information Systems in Assessing the Health of the Nashua River

Nick DePaula and Tim Maclaughlin (Huang). Studying Public Health in Fitchburg Using GIS

Jon Barto (Huang). GIS Internship with City of Gardner

Sam Gallagher (Huang). Adventure does the Soul Good: Why every person should spend time abroad

2019

Ed Zink (Huang). GIS Internship with the Leominster Department of Planning & Development

Jesse Corbin (Huang). GIS Internship with the Snow-riders of the Nashaway

Sean Beverly (Huang). Designing and Printing a 3D Model of the Nashua River Watershed

Sam Gallagher (Huang). The Analysis of the Land Use and Land Cover of the Nashua River Watershed

Caroline Anderson (Huang). Simulations of the Nashua River Flooding in Fitchburg

Caroline Anderson (Huang). Mapping the Opioid Epidemic in Fitchburg

Samantha Richard (Gordon). Microplastics in the Nashua River Watershed

Tallie Foster (Gordon). Recognizing Environmental Racism and Confronting Ecologic Privilege

Anne Saball (Gordon). A Submerging Paradise: Climate Change in the Polynesian Islands

Silas Belvin (Gordon). The Challenges of Climate Change in Indonesia

Maeve Ahern (Gordon). Feeding the World's Population One Underwater Plant at a Time

Loryn Killay (Gordon). The Meat Industry: What's at Steak?

Erinn Melus (Gordon) Conservation of Biodiversity Hotspots: Critical Regions of the World

Jace Petterson (Gordon). The Sedimentation and Geomorphology of the Nashua River

Samantha Richard (Gordon) Costa Rica: A Sustainability Leader of the World

Appendix F. Faculty

Table I. Faculty qualifications

Name	Rank	TT, T, NTT	FT or PT	Highest Degree	Very Brief description of Activity		
					Teaching	Scholarship	Service
Elyse Clark	Asst P	TT	FT	PhD	Hydrogeology, Soils, Geology, Earth Science	Hydrogeochemistry	Department Curriculum Committee, Undergraduate Research Cmte, Sustainability Cmte
Elizabeth Gordon	P	T	FT	PhD	Oceanography, Meteorology, Climatology, Climate Change and Human History, Honors Seminar, Geographic Perspectives	Aquatic organic geochemistry; Geoscience education	Department Curriculum Cmte, AUC Curriculum, Liberal Arts and Sciences, University Assessment, FYE
Jane Huang	P	T	FT	PhD	Intro to Geospatial Analysis, GIS, Web GIS, GISII, GIS for CJ, Urban Geography, Computer Cartography	Geographic Information Systems	Department Curriculum Cmte, Library Advisory Cmte, Crocker Center Advisory Board, Equity and Diversity, Academic Policies
Tina Morin	I	NTT	FT	MS	General Physics, Astronomy		
Reid Parsons	Asst P	TT	FT	PhD	Planetary Science, Geology, Environmental Geology, Remote Sensing, Geographic Perspectives, Honors Seminar, Geomorphology	Mars climate /geomorphology	Department Curriculum Committee, Chair of Sustainability Committee
Jiang Yu	P	T	FT	PhD	General and Calculus-based Physics	Physics Education	AUC Policies, College Board AP Physics Consultant

Table II. Faculty demographics

Demographic Faculty Summary	No. of Full Time Assigned to Unit	No. of Part Time Assigned to Unit
Women	5	1
Men	1	5
Ethnicity		
White/Caucasian	4	5
Asian	2	
Hispanic/Latino		
Black/African American		
American Indian		
International or Other		1
Credentials – highest degree held		
Bachelor's Degree		
Master's Degree	1	4
Doctorate	5	2
Experience		
0-3 years	1	2
4-7 years	1	1
8-11 years		2
12-15 years	3	
16-24 years	1	1
25+ years		

Table III. Teaching responsibilities

Full time faculty

Faculty member	Courses taught or planning to teach
Elyse Clark	Earth Systems Science, Geology, Geomorphology, Environmental Hydrogeology, Water Resources and Society (new), Environmental Geology, Soils and the Environment (new)
Elizabeth Gordon	Earth Systems Science, Oceanography, Meteorology, Climatology, Climate Change and Human History, Geographic Persp on Conservation, Honors Seminar in Environmental Science, FYE
Jane Huang	Intro Geospatial Analysis, Computer Cartography, GIS, GISII, WebGIS, Urban Geography, GIS for CJ
Tina Morin	Astronomy, General Physics I and II
Reid Parsons	Earth Systems Science, Geology, Environmental Geology, Geomorphology, Remote Sensing, Planetary Science, Geographic Persp on Conservation, Honors Seminar Environmental Science
Jiang Yu	General Physics I and II, Calculus-based Physics I and II

Adjunct faculty who have taught more than two semesters.

Faculty member	**Courses taught**
Kyle Anderson	Meteorology, Physical Science, Physics
Dr. Rudra Aryal	General Physics I and II
Dr. Jo Anne Carr	Earth Systems Science; Environmental Policy
Joseph Dignam	Physical Science, General Physics I and II
Dr. Chaitanya Hiremath	General Physics I and II
Robert Lavergne	General Physics I and II
Joseph Occhipinti	Human Geography, Political Geography, Population Geography, US and Canada, Latin American Geography

Elyse V. Clark, Ph.D.

Fitchburg State University
Department of Earth and Geographic Sciences
160 Pearl Street
Fitchburg, MA 01420

E-mail: eclark12@fitchburgstate.edu
Phone: (978) 665-4794

PROFESSIONAL APPOINTMENTS

Assistant Professor, Department of Earth and Geographic Sciences,
Fitchburg State University, Fitchburg, MA — September 2018 - present

Visiting Assistant Professor, Department of Geology and Environmental Earth Science,
Miami University, Oxford, OH — August 2017- May 2018

EDUCATION

Ph.D. *Hydrogeochemistry,* **Virginia Tech** — May 2017
Dissertation: Hydrologic and hydrochemical processes on mine spoils

B.S. *Environmental Science (with Dept. Honor*s), **University of Mary Washington** — May 2013
Second Major: *Geology*
Honors Thesis: Spatial and historical analysis of the distribution of polycyclic aromatic hydrocarbons in surface water bodies of the lower Chesapeake Bay watershed

COURSES TAUGHT OR CURRENTLY TEACHING

Earth Systems Science
Geology
Geomorphology
Environmental Hydrogeology
Environmental Geology
Water Resources and Society
Fundamentals of Environmental Science

RESEARCH EXPERIENCE

Evaluation of land use change impacts on watershed sedimentation and contaminants:

- Age-dating of sediment cores via Cs-137 and Pb-210 techniques
- GIS-based land use/land cover and soil erosion analyses
- Trace metal accumulation and enrichment in reservoir sediment
- Spatiotemporal polycyclic aromatic hydrocarbon (PAH) distribution in sediment

Understand and quantify surface coal mining impacts on soils and hydrochemistry, including:

- Evaluation of temporal release patterns of major and minor ions to streams
- Mineralogical and geochemical properties influencing dissolved salt generation
- Infiltration properties in response to vegetative treatments on disturbed soils
- Characterization of subsurface flow path development in disturbed soils
- Characterization of bioaccumulation potentials of toxic metals (e.g. As, Se, Pb)

Assessing the impact of urbanization on stream geomorphology, including:

- Stream sediment sampling and characterization
- Determination of stream dimensions and baseflow discharges
- Estimation of stream flood discharges

PEER-REVIEWED PUBLICATIONS

1) **Clark, E.V.,** C.E. Zipper, W.L Daniels, and M.J. Keefe. 2018. Appalachian coal mine spoil elemental release patterns and depletion. *Applied Geochemistry* 98:109-120.

2) **Clark, E.V.**, W.L. Daniels, C.E. Zipper and K.E. Eriksson. 2018. Mineralogical influences on water quality from weathering of surface coal mine spoils. *Applied Geochemistry* 91: 97-106. DOI 10.1016/j.apgeochem.2018.02.001

3) **Clark, E.V.,** W.L. Daniels, C.E. Zipper, Z.W. Orndorff, and M.J. Keefe. 2017. Modeling patterns of total dissolved solids release from Central Appalachia, USA mine spoils. *Journal of Environmental Quality* 46: 55-63. DOI 10.2134/jeq2016.04.0149

4) **Clark, E.V.,** B.M. Greer, E.T. Hester, and C.E. Zipper. 2016. Specific conductance-stage relationships in Appalachian valley fill streams. *Environmental Earth Sciences* 75: 1222. DOI 10.1007/s12665-016-6026-2

5) **Clark, E.V.** and C.E. Zipper. 2016. Vegetation influences near-surface hydrological characteristics on a surface coal mine in eastern USA. *Catena* 139: 241-249. DOI 10.1016/j.catena.2016.01.004

6) **Clark, E.V.,** B.K. Odhiambo, S. Yoon, and L. Pilati. 2015. Hydroacoustic and spatial analysis of sediment fluxes and accumulation rates in two Virginia reservoirs, USA. *Environmental Science and Pollution Research* 22:8659-8671. DOI 10.1007/s11356-014-4050x

7) **Clark, E.V.,** B.K. Odhiambo, and M.C. Ricker. 2014. Comparative analysis of metal concentrations and sediment accumulation rates in two Virginia reservoirs, USA: Lakes Moomaw and Pelham. *Water Air and Soil Pollution* 225:1860. DOI 10.1007/s11270-013-1860-2

BOOK CHAPTER IN REVIEW

1) **Clark, E.V.,** C.E. Zipper, D.J. Soucek, and W.L. Daniels. Contaminants in Appalachian Water Resources Generated by Non-Acid-Forming Coal Mining Materials. In: *Ecology and Management of Appalachian Coal-Mined Landscapes*. Springer. To be published June 2020

CONFERENCE PRESENTATIONS AND PAPERS

1) Anderson C., E.S. Gordon, J.P. Ludlam, D. Welsh, J. Huang, **E.V. Clark**, B. Levy. 2020. From Student Researcher to Mentor: Assessing the Health of the Nashua River in Massachusetts. To be presented by student at Ocean Sciences Meeting, San Diego, CA. 16-23 Feb.

2) Salaiz, A., Weissman T., and **E.V. Clark**. 2019. Hydrogeochemistry of the Nashua River Tributaries. Student-Faculty Collaborative Summer Research Experience Presentations. Fitchburg State University, Fitchburg, MA. 25 Jul.

3) **Clark, E.V.** 2018. Hydrogeochemistry Research Overview. 5th Annual Science Symposium at Fitchburg State University. Fitchburg, MA 11 Oct.

4) Rihl, G., A. Franklin, B.K. Odhiambo, L. Giancarlo, and **E.V. Clark**. 2017. Sediment Accumulation Rates and Trace Metal Input History in Lake Manassas and the Occoquan Reservoir, Virginia, USA. National Geologic Society of America Meeting, Seattle, WA. 22-25 Oct.

5) **Clark, E.V.,** C.E. Zipper, W.L. Daniels, Z.W. Orndorff, and M.J. Keefe. 2017. Release of Soluble Elements from Central Appalachian Mine Spoils. Virginia Coal and Energy Alliance Professional Engineers' Seminar. Lebanon, VA. 30 Mar.

6) **Clark, E.V.,** C.E. Zipper, B.M. Greer, J. Buckwalter, and E.T. Hester. 2016. Surface Coal Mining Disturbance Effects on Stream Hydrochemistry in Appalachia. American Geophysical Union National Meeting, San Francisco, CA. 12-16 Dec.

7) **Clark, E.V.,** C.E. Zipper, W.L. Daniels, Z. Orndorff, and M.J. Keefe. 2016. Modeling the Leaching Patterns of Central Appalachian Mine Spoils. National Geologic Society of America Meeting, Denver, CO. 25-28 Sept.

8) **Clark, E.V.,** and C.E. Zipper. 2016. Hydrologic Processes and Discharge Chemistries on Surface Mined Lands in Southwestern Virginia. Poster presented at Virginia Tech Department of Crop and Soil Environmental Sciences Research Symposium, 5 Feb.

9) Zipper, C.E., **E.V. Clark**, W.L. Daniels and R.J. Krenz. 2015. Mine Spoil Fill Construction for Reducing Total Dissolved Solids in Discharged Waters. 2nd Environmental Considerations in Energy Production conference, Pittsburgh, PA. 20-23 Sept.

10) **Clark, E.V.**, C.E. Zipper. 2015. Infiltration Studies on Mine Spoil Fills. Virginia Department of Mines Minerals and Energy (DMME) Mining Water Quality Meeting. Blacksburg, VA. 18 June.

11) **Clark, E.V.,** W.L. Daniels, Z. Orndorff, C.E. Zipper, and K. Eriksson. 2015. Evaluation of Appalachian Mine Spoil Leachate Chemistry and its Associated Geochemical Influences. National Meeting of the American Society of Mining and Reclamation, Lexington, KY. 7-11 June.

12) Zipper C.E., R.J. Krenz, **E.V. Clark**, and W.L. Daniels. 2015. Evaluation of Total Dissolved Solids Concentrations from Valley Fills. Proceedings of the West Virginia Mine Drainage Task Force Symposium, Morgantown, WV. 31 March-1 April.

13) Zipper, C.E., W. L. Daniels, R.J. Krenz, **E.V. Clark**, and D.M. Evans. 2015. Update on Low TDS Valley Fill Project. Virginia Coal and Energy Alliance Professional Engineers' Seminar, Wise VA. 4 Mar.

14) **Clark, E.V**. and C.E. Zipper. 2014. Assessment of the Near-surface Hydrological Characteristics of 12 Year Old Grassed and Forested Sites on a Reclaimed Coal Mine in Southwestern Virginia. National Meeting of the Geologic Society of America, Vancouver, BC. 19-22 Oct.

15) **Clark E.V.,** C.E. Zipper, D.M. Evans, R.J. Krenz. 2014. Physical and Chemical Discharge Patterns from Valley Fills in Southwestern Virginia. Powell River Project Symposium. Wise, VA. 10 Sept.

16) Evans, D.M., C.E. Zipper, and **E.V. Clark.** 2014. Monitoring Experimental Valley Fills Designed for Reduction of Total Dissolved Solids in Discharged Waters. National Meeting of American Society of Mining and Reclamation, Oklahoma City, OK. 14-20 June.

17) **Clark, E.V.** and B.K. Odhiambo. 2012. Comparative Analysis of Watershed Erosion, Reservoir Sedimentation and Sediment Trace Metals in Two Virginia Lakes. National Meeting of the Geological Society of America, Charlotte, NC. 4-7 Nov.

PROFESSIONAL ORGANIZATIONS

American Geophysical Union
Geological Society of America

SERVICE

Departmental Assessment Committee
Departmental Curriculum Committee
Undergraduate Research Conference Committee
Sustainability Committee

ELIZABETH SIOBHAN GORDON

Fitchburg State University
Earth and Geographic Sciences
160 Pearl Street
Fitchburg, MA 01420

Work: (978) 665-3083
Fax: (978) 665-3081
Mobile: (978) 894-5133
egordon3@fitchburgstate.edu

PROFESSIONAL APPOINTMENTS

Department Chair, Earth and Geographic Sciences, Fitchburg State University, 2015 - present

Professor, Earth and Geographic Sciences, Fitchburg State University, 2019 - present

Associate Professor, Earth and Geographic Sciences, Fitchburg State University, 2014-2019

Assistant Professor, Geo/Physical Sciences, Fitchburg State University, 2007-2014

Adjunct Assistant Professor, Dept. of Geosciences, UMass-Amherst, Amherst, MA, 2007-2010

EDUCATION

Ph.D. 2004. Marine Science, University of South Carolina.
Advisor: Miguel A. Goñi. Dissertation: *Sources and fate of terrigenous organic matter in modern and ancient sediments from the northern Gulf of Mexico.*

B.S. 1995, *Cum Laude*. Chemical Oceanography, University of Washington.
Advisor: Paul D. Quay. Senior thesis: *An oxygen budget for SteamboatSlough*.

TEACHING ACTIVITIES AT FITCHBURG STATE UNIVERSITY

Undergraduate courses: Introductory courses: *Earth System Science*; *Earth, Sea, and Air*; *Meteorology*; *Oceanography*; *Honors Seminar in Earth Science*; *Climate Change and Human History* (co-taught with Ben Lieberman); *Environmental Geology (including online);* Upper division courses: *Climatology*; *Planetary Atmospheres*, *Geographic Perspectives on Conservation; Remote Sensing*

Graduate courses: *Meteorology*; *Oceanography; Physical Science of Environmental Change* (co-taught with Chris Picone); *Environmental Geology* (online); *Climatology*

Professional Development courses for in-service teachers: *Teaching Earth and Space Science (online),* 2010-12; *Physical Science of the Solar System* (co-taught with Mark Snyder), 2010; *Chemistry of Environmental Change* (co-taught with Chris Picone), 2009; *Physical Science of the Environment* (co-taught with Chris Picone), 2008

ACADEMIC DISTINCTIONS

- Fitchburg State University *Faculty Service Award*, 2017
- University of South Carolina *Vernberg Award for Outstanding Peer-reviewed publication*, 2004
- University of South Carolina *Dean's Award for Excellence in Graduate Study*, 2003
- American Geophysical Union *Outstanding Student Poster Award*, 2002
- University of South Carolina Graduate School *Professional Travel Grant*, 1999, 2001
- Invited Participant, Natl Acad. Sciences *Symposium on Fifty Years of Ocean Discovery*, 1998
- Phi Beta Kappa Honor Society

ACADEMIC AND PROFESSIONAL SERVICE

- **Project Coordinator**, Fitchburg State Summer Research Collaborative, 2017-19
- **STEM Coordinator**, Fitchburg State University, 2015-17

Assist in organizing STEM professional development activities at Fitchburg State, including the STEM Summit (Jan 2015), Interdisciplinary Science working group (2015-17), STEM working group (2016-17), and serving as Fitchburg State's representative on the executive board of AAC&U's Project Kaleidoscope MA Regional Chapter (2015-present).

- Section Officer, National Association of Geoscience Teachers New England Section: **Councilor**, 2016-present; Outstanding Earth Science Teacher Award **Committee Chair** 2015-17; **President**, 2015; **Vice President #1**, 2014; **Vice President #2**, 2013
- **Assessment Researcher**, Learning Assessment Research Consortium, 2014-16
- **Curriculum Scholar**, Fitchburg State Univ./Mount Wachusett Comm Coll Collaborative, 2014-15
- **Assessment Scholar**, Fitchburg State Univ./Mount Wachusett Comm Coll Collaborative, 2012-14
- Fitchburg State University Committees and working groups:
  - First Year Experience, AY17-19
  - University Research and Assessment (UARC), AY17-19
  - Campus Compact Planning Committee, AY17
  - Civic Learning working group, AY16-17
  - Interdisciplinary working group, AY16-17
  - LA&S Council, AY11-present, **Chair** AY15, summer working group, 2016 and 2018
  - All University Committee, AY14, 15
  - Internship Policies Committee, AY13
  - ACC Curriculum, AY10, 11
  - ACC Policies, AY08, 09
  - **Co-Chair**, NEASC Student Subcommittee, AY11, 12
  - Undergraduate Research Conference, AY11, 12
  - Sustainability Advisory Committee, AY08-13
  - Safety Committee, AY08, 09
  - Honors Curriculum Committee, AY09-13
  - Departmental Assessment, AY11-present, Curriculum AY08-present, and Budget, 08-10
- **Workshop Leader**, *The Math You Need When You Need It*, 2012

RESEARCH ACTIVITIES

- Summer Research Collaborative, 2017-2019
- Research Fellow, Department of Geosciences, University of Massachusetts-Amherst, 2007.
- Postdoctoral Research Associate**,** Biogeochemistry Laboratory, UMass-Amherst, 2005-2007.
- Graduate Research Fellow**,** Organic Geochemistry Laboratory, USC, 1997-2004.
- Research Technician, Aquatic Geochemistry Laboratory, UW School of Oceanography, 1996-97.
- Undergraduate Research Assistant, Stable Isotope Laboratory, UW School of Oceanography, 1993-95.

Manuscript reviewer. Journals: *Limnol Ocean; Mar Chem; Cont Shelf Res; Geochim Cosmochim Acta; Deep Sea Res; Sci Total Environ; Environmental Science and Technology; Journal of Geophysical Research: Biogeosciences; Journal of Marine Systems; The Holocene*

Proposal reviewer: National Oceanic and Atmospheric Administration (panelist), National Science Foundation, American Chemical Society.

Textbook reviewer: Pearson, Jones and Bartlett

RESEARCH FUNDING

- Lloyd G. Balfour Grant, 2017-19
- Special Projects Fund, Fitchburg State University, 2011; 2015
- Ruth Butler Grant, Fitchburg State College, 2009
- President's Initiative Funds Fitchburg State College, 2008
- National Science Foundation Small Grants for Exploratory Research (SGER), 2005
- European Association for Organic Geochemists *Travel Scholarship*, 2005
- Environmental Protection Agency *Science to Achieve Results Fellowship*, 2001-2004
- National Science Foundation *Graduate Research Fellowship*, 1998-2001
- University of South Carolina *Graduate School Fellowship*, 1997

MEMBERSHIPS IN PROFESSIONAL SOCIETIES

- American Geophysical Union
- National Association of Geoscience Teachers
- Geological Society of America
- American Society of Limnology and Oceanography
- The Oceanography Society

PROFESSIONAL PRESENTATIONS/MEETINGS

Downs E.; **Gordon E**.; Huang J.; Ludlam J.; O'Connor A.; Welsh D., 2019. Fitchburg State University Summer Research Collaborative: An Interdisciplinary Research Experience to Improve STEM Retention and Graduate School Attendance, American Society of Limnology and Oceanography Aquatic Sciences Meeting, San Juan, Puerto Rico.

Palinkas C.M., **Gordon E.S.** (Co-conveners), 2018. GeoEthics and the Responsible Conduct of Scientists as Professionals and Educators Town Hall, Ocean Sciences Meeting, Portland, OR.

Gordon E.S., Palinkas C.M. (Co-chairs), 2016. Ethical Principles and Practices in the Ocean Sciences – Poster Session, Ocean Sciences Meeting, New Orleans, LA.

Gordon E.S., Cratsley C.K., Soucy D., 2014. Assessing Civic Knowledge and Engagement across Institutions, NEEAN Fall Forum, Worcester, MA.

Gordon E.S., 2014. Supporting student success in geoscience courses with The Math You Need When You Need It. Geological Society of America Annual Meeting, Vancouver, BC.

Gordon E.S., 2013. Implementing The Math You Need, When You Need It: An effective strategy to support underprepared students in introductory geoscience courses. Geological Society of America Annual Meeting, Denver, CO.

Gordon E.S., 2013. Implementation of "The Math You Need When You Need It" to support student learning in Introductory Oceanography. American Society of Limnology and Oceanography Aquatic Sciences Meeting, New Orleans, LA.

Cratsley C.K., Berg J., **Gordon E.S.**, 2012. More than One Way to Assess QR? AMCOA Statewide Conference, Worcester State University, Worcester MA.

Gordon E.S., 2012. Supporting student success in introductory geoscience at Fitchburg State University using The Math You Need When You Need It. Geological Society of America Annual Meeting, Charlotte, NC.

Gordon E.S., 2011. Improving quantitative skills in introductory geoscience courses at a four-year public institution using online math modules. American Geophysical Union Annual Fall Meeting, San Francisco, CA

Cratsley C.K., Berg J., Moser J., **Gordon E.S**., Railton B., 2011. Liberal Arts and Sciences Outcomes Assessment: Closing the loop or spiraling in the right direction? NEEAN Fall Forum, Worcester, MA and AMCOA Conference, Worcester MA.

Gordon E.S., Schillaski S.E., Petrik C. and Petsch S.T., 2008. Spatial and temporal variability in molecular composition of riverine organic matter delivered to the US Atlantic coast. American Geophysical Union, Ocean Sciences Meeting.

Gordon E.S., Allison, M.A., and Petsch S.T., 2006. Offshore mobilization and microbial uptake of aged floodplain organic matter in response to Hurricane Katrina. American Geophysical Union, Ocean Sciences Meeting, Honolulu, HI.

Gordon E.S. and Goñi M.A., 2005. Sedimentary controls on the distribution of terrigenous organic matter across the Mississippi-Atchafalaya River Margin. American Society of Limnology and Oceanography, A Pilgrimage through Global Aquatic Sciences Meeting.

COMMUNITY PRESENTATIONS

Climate Change: Current Science and the National Climate Assessment Report. Lunenburg Public Library, April 24, 2019

Panel discussion, with Drs. Erin Rehrig and Emma Downs, *Girls of Atomic City*. Lunenburg Public Library, March 19 2018. (Part of the Fitchburg State Community Read program)

Panel discussion, with Drs. Eric Budd, Emma Downs, Kate Jewell, and John Schaumloffel, *Girls of Atomic City*. Fitchburg State University Library, September 20, 2017. (Part of the Fitchburg State Community Read program)

Four-part series, with Brion Keagle, *Growing Great Gardens.* Center for Professional Studies, Fitchburg State April 19-May 10, 2011

Co-presented, with Brion Keagle and Chris Picone *Growing Gardens*. Center for Professional Studies, Fitchburg State, May 25 2010

Co-presented, with Dr. Chris Picone, *Global Warming: Science, Hype, or Hoax*. Center for Professional Studies, Fitchburg State, April 6 2010

SELECT PUBLICATIONS

BOOK

Benjamin Lieberman and Elizabeth Gordon, Climate Change in World History (2018). Bloomsbury Publishing.

PEER-REVIEWED ARTICLES

Allison M.A., Dellapena T.S., **Gordon E.S**., Mitra S., Petsch S., 2010. Impact of Hurricane Katrina (2005) on shelf organic carbon burial and deltaic evolution. Geophysical Research Letters 37, L21605, doi:10.1029/2010GL044547

Goñi M.A, Alleau Y., Corbett R., Walsh J.P., Mallison D., Allison M.A., **Gordon E.S.**, Petsch S., Dellapena T.S., 2007 (invited manuscript). The Effects of Hurricanes Katrina and Rita on the Seabed of the Louisiana Shelf. The Sedimentary Record 5, 4-9.

Goñi M.A, **Gordon E.S.**, Monacci N.M., Clinton R., Gishewhite R., Allison M., Kineke G., 2006. The effect of Hurricane Lili on the distribution of organic matter along the Inner Louisiana Shelf (Gulf of Mexico, USA). Continental Shelf Research 26, 2260-2280.

Jane Huang (Formerly Jane Xinxin Zhang)
Earth and Geographic Sciences Fitchburg State University 160 Pearl St. Fitchburg MA 01420
Phone: 978.665.3496 Email: jhuang2@fitchburgstate.edu

EXPERIENCES

TEACHING

2017-present	*Professor*, Fitchburg State University
2012-2017	*Associate Professor*, Fitchburg State University
2006-2012	*Assistant Professor*, Fitchburg State University
2006	*Instructor*, University of Idaho, Moscow, ID (part-time)
2001-2003	*Teaching Assistant*, University of Idaho, Moscow, ID (part-time)
1999-2001	*Teaching Assistant*, Washington State University, Pullman, WA (part-time)
1998-1999	*Instructor*, Xi'an Jiaotong University, Xi'an, China

COURSES TAUGHT AT FITCHBURG STATE UNIVERSITY

GEOG 1000:	Earth Systems Science
GEOG 1100:	Principles of Human Geography
GEOG 2xxx:	Geology and Environmental Mapping in Peru (scheduled in Spring 2021)
GEOG 2250:	Honors Seminar in Earth Science
GEOG 2400:	Intro to Geospatial Technologies
GEOG 3004:	GIS for Criminal Justice (cross-listed with CJ 3004)
GEOG 3120:	Computer Cartography
GEOG 3300:	Urban Geography
GEOG 3400:	Population Geography
GEOG 4000:	Geographic Information System (GIS)
GEOG 4001:	Web GIS
GEOG 4003:	Geographic Information System II (GIS II)
GEOG 4900:	Independent Study in Geography
GEOG 4940:	Internship in Geography
GEOG 4975:	Directed Study

RESEARCH

2005-2006	*Postdoctoral Researcher*, Washington State University, Pullman, WA
2000	*Research Assistant*, Washington State University, Pullman, WA (part-time)

EDUCATION

2005	Ph.D. in Geography (GIS), University of Idaho, Moscow, ID
2001	Master of Regional Planning, Washington State University, Pullman, WA
1998	Bachelor of Engineering in Architecture, Xi'an Jiaotong University, Xi'an, China

RESEARCH ACTIVITIES

GRANTS

2019-2020	Co-investigator, *Worcester County Overdose Death Response Initiative*. $360,000. In joint research coordination with the Middle District Attorney's Office and Fitchburg State University Criminal Justice Program. Part of the Bureau of Justice Assistance Innovative Prosecution Program in innovative prosecution solutions for combating violent crime and illegal opioids in Worcester County. Involved two (2) students.
2019	Co-investigator, *Study Abroad Scouting Trip to Peru*. MSCA Professional Development Fund of $2,800. Scouting geological and environmental sites in preparation for the first study abroad course of the department titled *Geology and Environment Mapping in Peru* with Dr. Elyse Clark.

2019 Summer. Co-investigator, *Student-Faculty Collaborative Summer Research Experience Program.* Third year of the three-year $240,000 grant project funded by the Lloyd Balfour Foundation, the Community Foundation of North Central Massachusetts, and Avantor Sciences Foundation. In collaboration with eleven (11) professors and twenty-two (22) students. Supervisor of one (1) student on the Health of Nashua River Project.

2018 Summer. Co-investigator, *Student-Faculty Collaborative Summer Research Experience Program.* Second year of the three-year $240,000 grant project funded by the Lloyd Balfour Foundation and the Community Foundation of North Central Massachusetts. In collaboration with ten professors and twenty students. Supervisor of two (2) students on the Health of Nashua River Project.

2018 Spring. *Ingleside Trail Survey and Mapping Project in Winchendon MA*. $100. Using GPS and GIS to survey and map Ingleside trails upon the request of Winchendon Ingleside Utilization Committee. Involved twelve (12) students in the GEOG2400 class. The funding was to cover students' travel costs.

2018 Spring. Building a Web GIS Platform. $2000. Joint grant of Crocker Center for Civic Engagement, ReImagine North of Main, City of Fitchburg, and Montachusett Opportunity Council. Involved one (1) student.

2017 Fall. Fitchburg Commercial and Industrial Property Inventory and Mapping. $8,500. Joint grant of Crocker Center for Civic Engagement, ReImagine North of Main, City of Fitchburg, and Montachusett Opportunity Council. Involved four (4) students.

2017 Summer. Co-investigator, *Student-Faculty Collaborative Summer Research Experience Program.* First year of the three-year $240,000 grant project funded by the Lloyd Balfour Foundation. In collaboration with eight professors and eighteen students. Supervisor of four (4) students on two projects: the Health of Fitchburg Communities Project and the Health of Nashua River Project

2017 Spring. Second extension of the *Neighborhood Property Mapping & Analysis Project* (Spring). Crocker Center for Civic Engagement Research Grant. $4,500. Conducted in-depth mapping and spatial analysis of the neighborhood north of Main St, Fitchburg using GIS technology. Continued to Assist Montachusett Opportunity Council, NewVue Communities and City of Fitchburg in assessing the neighborhood. Involved two (2) students.

2016 Fall. First extension of the *Neighborhood Property Mapping & Analysis Project* (Fall). Crocker Center for Civic Engagement Research Grant. $4,500. Conducted in-depth mapping and spatial analysis of the neighborhood north of Main St, Fitchburg using GIS technology. Continued to Assist Montachusett Opportunity Council, NewVue Communities and City of Fitchburg in assessing the neighborhood. Involved two (2) students.

2016 Spring. Crocker Center for Civic Engagement Research Grant (Spring). $9,000. In joint research coordination with Prof. Keith Chenot of Architecture. *Neighborhood Property Mapping & Analysis Project*. Conducted mapping and spatial analysis of the neighborhood north of Main St, Fitchburg using GIS technology. Assisting Montachusett Opportunity Council, NewVue Communities and City of Fitchburg in assessing the neighborhood. Involved two (2) students.

2015 Montachusett Regional Planning Commission (MRPC) Project. $200. *GPS Survey of Healthy-Heart Trails.* Led the class of Geog2400: Computer Application in Geosciences to assist MRPC in evaluating potential healthy-heart hiking trails in the Montachusett region using GPS (Global Positioning System). Involved seventeen (17) students. The funding was to cover students' travel costs.

2013-2014 Regional Economic Development Institute (REDI) Research Grant. One three-credit-hour course release. "*Traffic Mapping and Analysis in North Central MA*". Conducted

spatial and cartographical analysis of traffic accident patterns in the North Central MA area using GIS technology. Involved one (1) student.

2012-2013 Four REDI Research Grants (four research projects). Totally $4,000 and two three-credit-hour course release. Involved four (4) students.
Project 1: in joint collaboration with MRPC (Montachusett Regional Planning Commission) "*Community GIS Mapping for Regional Zoning, Transportation, Traffic, and Pedestrian Walkways*"
Project 2: "*Urban Structure Study of Fitchburg*". GIS research in Urban Planning.
Project 3: in joint collaboration with FPD (Fitchburg Police Department) "*Data Driven GIS Approaches to Crime and Traffic Safety in Fitchburg*"
Project 4: in joint research coordination with Dr. Luis Rosero of Economics "*Trends in Regional Economic Development across North Central Massachusetts*"

2012 Montachusett Regional Planning Commission (MRPC) Project. $200. *TravTime Traffic Congestion Study.* Led the class of Geog2400: Computer Application in Geosciences in a GPS survey project which assisted MRPC, MassDOT (Massachusetts Department of Transportation), and FHWA (Federal Highway Administration) by identifying and analyzing the most congested corridors in the Montachusett region. Involved ten (10) students. The funding was to cover students' travel costs.

2012 Special Projects Grant in Travel of the Academic Affairs. $700. Oral Presentation titled "*Involving Undergrad Students in GIS Research – the Bringing Broadband to North Central Massachusetts Project*" at the 27th Annual Conference of the Northeast Arc Users Group in Rockland Maine on November 11, 2012

2010-2012 REDI Research Grant. $2,500. In joint research coordination with Dr. Beverley Hollingsworth of Business. *Bringing Broadband to North Central Massachusetts.* REDI − Massachusetts Broadband Institute (MBI) − Montachusett Regional Planning Commission (MRPC) joint project. Conducted spatial and demographic analysis of the accessibility of the broadband high-speed Internet to residents, businesses, and public institutions across the North Central Massachusetts area using GIS technology. Involved one (1) student.

2011 Special Projects Grant in Faculty Scholarship of the Academic Affairs. $1,500. Purchased twelve Garmin eTrex handheld GPS units; supervised twelve (12) students on the GPS Survey of Community Trails Project which assisted the MRPC in their Trail Inventory Project in communities of Athol, Petersham, and Royalston.

2010 REDI Research Grant. One three-credit-hour course release. In joint research coordination with Prof. Michael Turk of Economics. *GIS Spatial & Trend Analysis – North Central Massachusetts at a Crossroads: Housing Challenges.* Constructed a GIS database of the economic parameters of North-Central Massachusetts with a focus on the housing market. Conducted spatial and trend analysis of the foreclosure pattern. Involved one (1) student.

2009 Crocker Center for Civic Engagement Grant. $750. *Trail Mapping Using GPS in Northern Fitchburg Watershed Area*. Assisted the MRPC and the North County Land Trust (NCLT) in their trail inventory study by supervising seven (7) students mapping the trails in the local watershed area using GPS technology.

2009 Second extension of the *Healthy Housing Initiative/Community De-Leading Project*. $3,000. Updated the geo-database with additional lead inspection data provided by the Mass Department of Public Health.

2008 First extension of the *Healthy Housing Initiative/Community De-Leading Project*. $4,600. Conducted extended spatial analysis of distributions of properties with high lead poisoning risk and of properties foreclosed in Fitchburg.

2007-2008 *Healthy Housing Initiative/Community De-Leading Project Grant*. $30,000. In joint with Montachusett Opportunity Council, Fitchburg Lead Action Group, Cleghorn

Neighborhood Center, Twin Cities Community Development Corporation, and the City of Fitchburg's Department of Community Development. Used GIS technology to identify hot-spots and high-risk properties for childhood lead poisoning in Fitchburg. Involved one (1) student.

2006 *Faculty Innovation Grant*. $2,500. Purchased a campus-wide site license of ArcGIS®, the major geospatial software program.

SELECTED PUBLICATIONS

2017 Kayla Kress, Jane Huang. *Standard Operating Procedure of Property Survey in the Fitchburg Communities*. Fitchburg State University Press.

2009 Jane X. Zhang, Joan Q. Wu, K.-T. Chang, William Elliot, Shuhui Dun. *Effects of DEM Source and Resolution on WEPP Hydrologic and Erosion Simulation: a Case Study of Two Forest Watersheds in Northern Idaho*. Transactions of the ASABE, Vol. 52(2), 447–457

2008 Jane X. Zhang, K.-T. Chang, Joan Q. Wu. *Effects of DEM Resolution and Source on Soil Erosion Modeling: a Case Study Using the WEPP Model*. International Journal of Geographical Information Science, Vol. 22(8), 925–942

SELECTED CONFERENCE PRESENTATIONS

2018 Debora Benes, Jane Huang, and Danielle Wigmore. *Physical Activity and Perception of Recreational Facilities in a Low Socioeconomic Community* (poster presentation), February 11-14. Active Living Research Conference 2018, Banff, Canada

2017 Jane Hang, Timothy Maclaughlin, Nicholas De Paula, Jacob Hogue, and Sean Beverly, *Studying Environmental & Public Health in the Fitchburg Area Using GIS*, Oct. 16. NEURISA (New England Urban & Regional Information Systems Association) Annual Conference, Fitchburg, MA

2017 Jane Huang, *Service Learning in Geospatial Technology Courses at Fitchburg State University*, June 7. Massachusetts PKAL Regional Network Summer Meeting, Fitchburg, MA.

2016 Jane Huang, Kayla Kress, Jacob Hogue, Samuel Gallagher (students), *Neighborhood Property Mapping & Analysis using GIS - Embracing Community Revitalization Project in Building GIS program at Fitchburg State University.* Nov 14. NEURISA (New England Urban & Regional Information Systems Association) Annual Conference, Fitchburg, MA

2014 Jane Huang, *Mapping Hotspots of Crime and Traffic Violation in Fitchburg, MA.* Oct 5–8. The 29th Annual Conference of the Northeast Arc Users Group, Groton, CT.

2013 Jane X. Zhang, *Teaching and Learning beyond Classroom – Leading Students on Local Projects Using GIS and GPS Technologies.* Mar 18–20. Geological Society of America (GSA) 2013 Northeastern Section Meeting, Bretton Wood, NH

2012 Jane X. Zhang, *Involving Undergrad Students in GIS Research – the Bringing Broadband to North Central Massachusetts Project.* Nov 11–14. The 27th Annual Conference of the Northeast Arc Users Group, Rockland, ME

2007 Jane X. Zhang, *Effects of DEM Resolution and Source on Soil Erosion Modeling*. Jun 18–22. ESRI (Environmental Systems Research Institute) International User Conference, San Diego, CA

2007 Jane X. Zhang, *Effects of DEM Resolution and Source on Soil Erosion Modeling Using the WEPP Model*. Apr 17–21. AAG (Association of American Geographers) Annual Meeting, San Francisco, CA

SELECTED TALKS

2020 Jan 29. *Conducting Community-Based Research from the Geospatial Technology Perspective*. A brief talk at the Community Engaged Research and Scholarship Event as part of the Diversifying the Faculty: Pathways Toward Equity Program, a $100,000 grant on civic and community engagement awarded to Fitchburg State University, Worcester State, and Salem State University.

2018 May 21. *Conducting Community-Based Research Using GIS and GPS Technologies* Faculty Research Symposium at Fitchburg State University.

2018 Feb. 28. *What Geospatial Technologies Can Do for The Fitchburg Community*. A brief talk at the Crocker Center Community Scholarship Group reception at the Montachusett Opportunity Council located in Fitchburg.

2017 Oct. 26. *Conducting Community-Based Research Using GIS and GPS Technologies*. Poster presentation at the Science Symposium at Fitchburg State University.

2017 Apr 21. Served in the Faculty Panel and talked to the Mount Wachusett Community College Gateway to College program dual enrollment students, Fitchburg State University

2013 Jun 10. *Trends in Regional Economic Development across North Central Massachusetts.* In joint presentation with Dr. Luis Rosero. REDI Public Research Forum, Fitchburg State University

2012 Nov 5. *Broadband Availability & Usage in North Central MA.* In joint presentation with Dr. Beverley Hollingsworth. REDI Public Research Forum, Fitchburg State University

2011 Nov 7. *Expanding Broadband Access in Massachusetts*. Presented along with student intern Patrick O'Brien. REDI Public Research Forum, Fitchburg State University

2010 Oct 4. *North Central Massachusetts at a Crossroads: Housing Challenges*. In joint presentation with Prof. Michael Turk. REDI Public Research Forum, Fitchburg State University

2008 Jul 22. *Mapping Using GPS & Google Earth.* Workshop Presentation in the Fourth Summer Institute, Fitchburg State College

2008 Apr 22. *Wealth & Environmental Health.* International Month Earth Day Talk: 6.5 Billion & Counting, Fitchburg State College

2007 Jun 8. *Using GIS for Lead Studies*. NSF GeoScience Education Directorate Workshop: Community Research and Service Learning Using GeoSpatial Tools, Worcester State College

PEER REVIEWS

2011 M. F. Goodchild. “Challenges in Geographic Information Science”. Proceedings A

2011 A. Sharma, K. N. Tiwari, P. B. S. Bhadoria. “Determining the Optimum Cell Size of Digital Elevation Model for Hydrologic Application”. Journal of Earth System Science

2010 P. S. Datta, H. Schack-Kirchner. “Erosion Relevant Topographical Parameters Derived from Different DEMs – A Comparative Study from the Indian Lesser Himalayas”. Remote Sensing

2007 A. Gollamudi, C. Madramootoo, P. Enright. “Water Quality Modeling of Two Agricultural Fields in Southern Quebec using SWAT”. Transactions of the ASABE

SELECTED CONFERENCES/MEETINGS ATTENDED

2019 Feb. ESRI Geodesign Summit in Redlands, CA

2019 Jan. One-day conference of Going Beyond Rubrics: The Impact of Community Engagement on Our Campuses in Worcester, MA

2018 Oct. One-day workshop of *Insights for ArcGIS* given by the ESRI Boston Office in Middleton, MA

2017 Oct. One-day course given by Dr. Edward Tufte "*Presenting Data and Information*" in Boston, MA.
2017 Jul. Fitchburg Trails Vision Committee Meeting, Fitchburg.
2017 Feb. Fun 'N FITchburg meeting at NewVue Communities in Fitchburg, by invitation of Tricia Pistone, Vice President of Planning, Policy and Development, Montachusett Opportunity Council
2017 Jan. Integrating Environment and Health – 17th National Conference and Global Forum for Science, Policy, and the Environment, in Washington D.C.
2016 Oct. The 31st Annual Northeast Arc Users Group Conference, North Falmouth, MA
2016 June. MA PKAL Regional Network Spring Meeting, a daylong workshop featuring best practices in higher education STEM pedagogy, in Westfield, MA
2016 May. Meeting with the Science and Mathematics Teachers of Nashoba Regional High School about university expectations for incoming science students, in Bolton, MA
2015 June. The Greater Quabbin Food Alliance Meeting in Orange, MA, by invitation of Sheri Bean, member of the Board of Directors of Central Mass Grown
2015 May. The "Data Day – Democratizing Data to Drive Community Change" at WPI, by invitation of Jason Stanton, GIS/IT Director, Montachusett Regional Planning Commission
2015 May. Dr. Brian Donahue's presentation of "A New England Food Vision" at Fitchburg Art Museum, by invitation of Janet Morrison, Executive Director of North County Land Trust
2014 Oct. The Guided Pathway to Successes – Central Mass Regional Meeting, Fitchburg State University, Fitchburg, MA
2011 Nov. The New England Educational Assessment Network Fall Forum, Worcester, MA
2010 Nov. The 25th Annual Northeast Arc Users Group Conference, Newport, RI
2009 Nov. The New England Educational Assessment Network Conference. College of the Holy Cross, Worcester, MA
2008 Apr. Association of American Geographers (AAG) Annual Meeting, Boston, MA
2007 Nov. The 22nd Annual Northeast Arc Users Group Conference, Burlington, VT
2007 Oct. Worcester Lead Poisoning Prevention Community Summit, Clark University, Worcester, MA, by invitation of Cynthia Soule, Coordinator, Fitchburg Lead Action Group (FLAG).
2006 Nov. "GIS Day" Conference at University of New Hampshire, Durham, NH

PROFESSIONAL AFFILIATIONS AND AWARDS

2005-present Association of American Geographers
2007-present Cartography and Geographic Information Society
2000 Robert and Wendi Lane Environmental Science Fellowship Award, Washington State University, $2,000

CONTRIBUTIONS TO THE PROGRAM

INPUT TO CURRICULUM

2020 In progress, AUC proposal for *Adding electives to GIS Crime Mapping & Analysis Minor curriculum*
2020 In progress, AUC proposal for *Changing the prerequisite of GEOG/CJ 3004 GIS for Criminal Justice*
2019 July. AUC approval for *New Course Proposal for Web GIS*
2019 July. AUC approval for *New Course Proposal for GIS II*
2019 July. AUC approval for *Adding Web GIS and GIS II to the GST major curriculum*
2018 May. AUC approval for *New Academic Program Proposal for the Environmental Public Health major,* an interdisciplinary program housed in the Earth and Geographic

Sciences department and in collaboration with Nursing, Biology and Chemistry, Exercise and Sports Science, Psychological Science, Economics, History, and Political Science, Behavioral Sciences, and Humanities. Co-sponsored with Deborah Benes and Elizabeth Gordon.

2018 May. AUC approval for *New Course Proposal for Public Health in the United States.* Co-sponsored with Deborah Benes and Elizabeth Gordon

2018 May. AUC approval for *New Course Proposal for Fundamentals of Epidemiology.* Co-sponsored with Deborah Benes and Elizabeth Gordon

2018 May. AUC approval for *New Course Proposal for Environmental Geology.* Co-sponsored with Deborah Benes and Elizabeth Gordon

2018 May. AUC approval for *New Course Proposal for Environmental Health.* Co-sponsored with Deborah Benes and Elizabeth Gordon

2018 May. AUC approval for *New Course Proposal for Environmental Policy.* Co-sponsored with Deborah Benes and Elizabeth Gordon

2018 May. AUC approval for *New Course Proposal for Evaluation Methods in Public.* Co-sponsored with Deborah Benes and Elizabeth Gordon *Health*

2018 May. AUC approval for *New Academic Program Proposal for the GIS Crime Mapping & Analysis minor,* an interdisciplinary program sponsored by Earth & Geographic Sciences and Behavioral Sciences. Co-sponsored with Marcel Beausoleil

2018 May. AUC approval for *New Course Proposal for GIS for Criminal Justice,* an interdisciplinary course co-taught with Behavioral Sciences. Co-sponsored with Marcel Beausoleil

2018 May. AUC approval for *Changes to the GST Major Requirements*

2018 May. AUC approval for *Changes to the GST Minor Requirements*

2015 Nov. AUC approval for *Add GEOG 2056 Climate Change and Human History to GST major and minor electives*

2015 Nov. AUC approval for *Lower the course level of GEOG4400 Urban Geography to 3xxx, and add a prerequisite*

2015 May AUC approval for *New Academic Program Proposal for the Geographic Information System (GIS) Minor*, an interdisciplinary program sponsored by Earth & Geographic Sciences, Computer Science, and Industrial Technology. Co-sponsored with Nadimpalli Mahadev

2015 Mar. AUC approval for *Change course name and prerequisite of Geog2400 Computer Application in Geosciences*

2013 Dec. AUC approval for *Modify the requirements of the Geographic Science and Technology major*

2013 Dec. AUC approval for *Modify the requirements of the Geographic Science and Technology minor*

2013 Feb. AUC approval for *Change program's name from "Geography" to "Geographic Science and Technology"*

2012 May. ACC approval for *Raise the course level of Geog 3500: Geographic Information System*

2012 May. ACC approval for *Lower the course level of Geog 4800: Computer Cartography*

2012 May. ACC approval for *Add alternative prerequisites of Geog 3200: US and Canada*

2010 Feb. ACC approval for *Change of Geography Major Elective Requirements*

2010 Feb. ACC approval for *Change of Geography Minor Requirements*

2010 Feb. ACC approvals for GEOG3400, 4400, and 4800 to be new LA&S Courses

2009 May. ACC approval for *Change of Geography Major Core Requirements*

2009 May. ACC approval for *Removing GOEG4820 Cartography II from Course List*

2008 Nov. ACC approval for *GEOG4800 Name Change* (Old: Cartography I; New: Computer Cartography)

2008 May. ACC approvals for GEOG1000, 1100, 2400, and 3500 to be New LA&S Courses
2007 Apr. ACC approvals for GEOG2400 and GEOG3500 to be LA&S Courses

INPUT TO STUDENT INTERNSHIPS & SCHOLARLY ACTIVITIES

2020 Feb. Co-author and faculty sponsor of a student poster presentation titled "*From Student Researcher to Mentor: Assessing the Health of the Nashua River in Massachusetts*" in the Ocean Sciences Meeting 2020, San Diego, CA.

2019 Apr. Faculty sponsor of six (6) presentations by five (5) students in the 10th Undergraduate Conference on Research and Creative Practice.
Presentation 1: *Geography Internship with the Leominster Department of Planning & Development* (Second Place Award of Oral Presentation)
Presentation 2: *GIS Internship with the Snow-riders of the Nashaway* (Third Place Award of Oral Presentation)
Presentation 3: *Designing and Printing a 3D Model of the Nashua River Watershed*.
Presentation 4: *The Analysis of the Land Use and Land Cover of the Nashua River Watershed*.
Presentation 5: *Simulations of the Nashua River Flooding in Fitchburg*.
Presentation 6: *Mapping the Opioid Epidemic in Fitchburg*

2019 Feb. Faculty sponsor of two poster presentations titled *The Analysis of the Land Use and Land Cover of The Nashua River Watershed* and *Simulations of the Nashua River Flooding in Fitchburg, Massachusetts* by two (2) students at the Association for the Sciences of Limnology and Oceanography (ASLO) Annual Conference in San Juan, Puerto Rico.

2018 Oct. Faculty sponsor of an oral presentation titled *GIS Analysis of Land Use and Potential Flooding in the Nashua River Watershed* by two (2) students at the NEURISA (New England Urban & Regional Information Systems Association) Annual Conference in Beverly, MA

2018 Apr. Faculty sponsor of a poster presentation titled *Application of GIS in Assessing the Health of the Nashua River* by two (2) students in the 6th Annual Environmental Research Colloquium held in Boston, MA

2018 Apr. Faculty sponsor of four (4) oral presentations by six (6) students in the 9th Undergraduate Conference on Research and Creative Practice.
Presentation 1: Application of Geographic Information Systems in Assessing the Health of the Nashua River
Presentation 2: Studying Public Health in Fitchburg Using GIS
Presentation 3: GIS Internship with City of Gardner
Presentation 4: Adventure does the Soul Good: Why every person should spend time abroad

2018 Apr. Helped organizing the GIS Club event of the guest talk by Susan Smiley and Cliff McMullan of the Snow Riders of the Nashaway Snowmobile Association of Mass.

2017 Nov. Faculty sponsor of a presentation on "Public Recreational Spaces and Physical Activity in North Central" at the Active Living CHIP Group Meeting, Fitchburg. Involved two (2) students.

2017 May. Helped organizing the GIS Club event of the guest talk by Jassy Bratko, the Director of Land Protection at North County Land Trust.

2017 Apr. Faculty sponsor of two (2) oral presentations by three (3) students in the 8th Undergraduate Conference on Research and Creative Practice.
Presentation 1: "GIS Mapping and Analysis for the Reimagine North of Main project";
Presentation 2: "GIS Internships with MRPC and Ayer DPW";

2017 Feb. Helped organizing the conservation restriction training program for six (6) students with the Mount Grace Land Conservation Trust in Athol, MA

2017 Spring. Supervising four (4) GIS/Geography internships on campus and at the sites of the Ayer Department of Public Works and the City of Fitchburg Water Department

2016 Nov. Helped organizing the GIS Club event of "Fitchburg GIS Night" at Clark University. Nineteen (19) students participated to a raster GIS workshop and attended GIS internship presentations hosted by graduate students of GIS at Clark University.

2016 Fall. Supervising four (4) GIS/Geography internships on campus and at the site of the Montachusett Regional Planning Commission

2016 Apr. Organized the first GIS Club event: a talk titled "GIS After Undergrad" to Geog4000 GIS and CSC4400 Software Engineering by Henry Mros, a 2015 alumnus and a master's student in GIS at Clark University.

2016 Apr. Faculty sponsor of five (5) oral presentations by a total of nine (9) students in the 7th Undergraduate Conference on Research and Creative Practice.
Presentation 1: "GIS Internship with the Ayer Department of Public Works" (First Place Award for Oral Presentation);
Presentation 2: "GPS Survey of Healthy-Heart Trails – A Service Learning Term Project of GEOG 2400" (Tied Third Place Award for Oral Presentation);
Presentation 3: "Neighborhood Property Mapping and Analysis using GIS";
Presentation 4: "Transportation Geography Internship with Montachusett Regional Planning Commission";
Presentation 5: "Land Conservation and GIS Internships with North County Land Trust"

2016 Sponsored Huy Vo, a CS student minoring in GIS, for the creation of the GIS Club. The club gained recognition from the University on March 4, 2016.

2016 Spring. Supervising four (4) GIS/Geography internships on campus and at the sites of the Ayer Department of Public Works and Montachusett Regional Planning Commission

2015 Nov. Organized two talks titled "GIS and the History, Development and Planning of Gardner", and "GIS, Thematic Mapping and Current Projects in Gardner" to Geog4400 Urban Geography and Geog3120 Computer Cartography, respectively, by Rachael Catlow, GIS Coordinator, City of Gardner

2015 Summer and Fall. Supervised four (4) GIS/Geography internships at the sites of the Ayer Department of Public Works, Montachusett Regional Planning Commission, and North County Land Trust

2015 Apr. Faculty sponsor of an oral presentation: "Inventorying Farmland with the North County Land Trust Using GIS" by three (3) students in the 6th Undergraduate Conference on Research and Creative Practice

2015 Built a long-term partnership with North County Land Trust (NCLT) and supervised thirteen (13) students' volunteer work in the North Central Mass Farmland Inventory Project by request of Janet Morrison, Executive Director of NCLT

2015 Feb. Organized a presentation to the GeoClub and BioClub titled "Lessons Learned from One Graduate's Tour through the Working World" by Scott Lehto, alumnus and GIS consultant for the Kenerson Group

2014 Apr. Faculty sponsor of two (2) oral presentations by two (2) students in the 5th Undergraduate Conference on Research and Creative Practice.
Presentation 1: "Predicting New England Bound Hurricane by Offshore Location";
Presentation 2: "GIS Internship with the Fitchburg Wastewater Department"

2014 Supervised a GIS internship at the Fitchburg Wastewater Department

2013 Apr. Faculty sponsor of three (3) oral presentations by four (4) students in the 4th Undergraduate Conference on Research and Creative Practice.
Presentation 1: "TravTime Traffic Congestion Study in the Montachusett Region";
Presentation 2: "Mapping Hotspots of Crime and Traffic Violation in Fitchburg";

Presentation 3: "Urban Structure Study of Fitchburg, MA"

2013 Supervised five (5) GIS/Geography internships at the sites of Gardner Department of Public Work and REDI.

2012 Apr. Faculty sponsor of two (2) oral presentations by three (3) students in the 3rd Undergraduate Conference on Research and Creative Practice.
Presentation 1: "GIS Analysis for the Project: Bringing Broadband to North Central Massachusetts"
Presentation 2: "GPS Survey of Community Trails"

2012 Supervised three (3) GIS/Geography internships at the sites of Fitchburg Police Department, Montachusett Regional Planning Commission, and REDI

2011 Apr. Faculty sponsor of two (2) oral presentations by four (4) students in the 2nd Undergraduate Conference on Research and Creative Practice.
Presentation 1: "My Involvement in the Project – Bring Board Band to North Central Massachusetts";
Presentation 2: "Mapping Stone Walls in the Crocker Conservation Area Using GPS and GIS Technologies"

2011 Built a long-term partnership with Montachusett Regional Planning Commission (MRPC) and supervised a GIS internship at the sites of MRPC and REDI

2011 Feb-Apr. Supervised nine (9) students' volunteer work in assisting North County Land Trust documenting the stone walls in the Crocker Conservation Area in Fitchburg using GPS and GIS technologies.

2010 Mar-Jul. Supervised nine (9) students' volunteer work in assisting Leominster Trail Stewards assessing trail conditions in Leominster using GPS technology

2010 Apr. Faculty sponsor of an oral presentation: "GPS Mapping of Fitchburg Watershed Trails – A Crocker Center Civic Engagement Project" in the 1st Undergraduate Conference on Research and Creative Practice

2009 Mar. Organized a presentation to the GeoClub by Jason Stanton, GIS Director of Montachusett Regional Planning Commission

DEPARTMENTAL SERVICES

2019-2020 Chair of the Peer Evaluation Committee for Dr. Elyse Clark's 2nd year reappointment.
2006-2020 Departmental Curriculum Committee
2017-2018 Chair of the Search Committee (brought in Dr. Elyse Clark)
2017-2018 Peer Evaluation Committee for Dr. Liz Gordon's Chair Evaluation
2016-2017 Involved in modifying the major program of Earth Systems Science to Environmental and Earth Science
2015-2016 Leader of the establishment of the Geospatial Technology Research Lab (Science 317)
2014-2015 Acting Chair in Spring 2015; Leader of the departmental self-study and external review, and of the major overhaul of the departmental webpage.
2014-2015 Peer Evaluation Committees for Dr. Bruce Duncan's Chair Evaluation and for Dr. Reid Parsons's 2nd year reappointment.
2013-2014 Departmental Assessment Committee; Peer Evaluation Committee for Dr. Liz Gordon's promotion to associate professor
2012-2013 Search Committee (brought in Dr. Reid Parsons)
2010-2012 Departmental Assessment Committee
2007-2008 Departmental self-study
2006-2007 Search Committee (brought in Dr. Liz Gordon)

CONTRIBUTIONS TO THE UNIVERSITY COMMUNITY

INTERDISCIPLINARY SERVICE PROGRAMS

2019-2020 One of the contributors to the Digital and Applied Humanities Work

2019-2020	One of the contributors to the new MBA concentration of Supply Chain Management & Logistics.
2015-2019	One of the initiators and creators of the Environmental Public Health major program. In collaboration with Dr. Debbie Benes of Nursing and Dr. Liz Gordon of Earth and Geographic Sciences. The program was approved by the BHE on March 12, 2019 and started running in Fall 2019.
2017-2018	One of the initiators and creators of the GIS Crime Mapping & Analysis minor program. In collaboration with Dr. Marcel Beausoleil of Behavioral Sciences
2016-2017	Participated in the STEM Group Plans Meetings organized by Dean Meg Hoey
2016-2017	Participated in the Campus Compact Civic Learning Meetings and involved in its action groups 1 and 2.
2014-2015	One of the initiators and creators of the GIS minor program. In collaboration with Dr. Nadimpalli Mahadev of Computer Science

COMMITTEE SERVICES

2018-2019	Library Advisory Committee
2017-2018	Crocker Center Advisory Board
2016-2017	Equity and Diversity Committee
2015-2016	Academic Policies Committee
2015 Fall	Peer Evaluation Committee for Dr. Billy Samulak's 2nd year reappointment
2015 Fall	Peer Evaluation Committee for Dr. Mathangi Krishnamurthy's 4th year reappointment
2014-2015	Ruth Butler Grant Committee
2014-2015	Academic Policies Committee
2013-2014	Student Conduct Board
2012-2013	Harrod Lecture Committee
2011-2012	International Advisory Committee
2010-2011	International Advisory Committee
2010-2011	Ruth Butler Committee
2009-2010	International Advisory Committee
2009-2010	Library Advisory Committee
2008-2009	Student Affair Committee
2007-2008	Equity and Diversity Committee
2007-2008	Technology Advisory Committee (Educational Enhancement Subcommittee)
2006-2007	Technology Advisory Committee

CAMPUS EVENT SERVICES

2019	Dec. Panel speaker at the Center for Faculty Scholarship discussion of "If I Knew Then What I Know Now: Balancing a 4/4 Course Load with an Active Research Agenda"
2019	Sep. Panel speaker at the Information Session on Scholarship and Research organized by the Provost
2019	May. Panel speaker at the Crocker/CTL Civic Engagement Institute at the ideaLab.
2017	May. Mentor to newer faculty members in the Summer Civic Engagement Institute.
2015	Nominator of Scott Lehto, the 2015 Young Alumni Recognition Awardee
2012	Participated in a video produced for the University Capital Campaign Closing Ceremony
2006-present	Many of annual services at events of Open House, Accepted Students Day, Winter/Summer Orientation Advising when needed

Tina E. Morin

198 Rogers Road, Hampton, CT 06247
Ph: 860.786.7502
zmn2380@gmail.com

Professional Summary

A confident, enthusiastic and hard working astronomy and physics instructor who is able to effectively communicate information to students from diverse backgrounds or varying degrees of ability. By encouraging students to visualize the subject material through their own eyes, Tina is a committed and dedicated professional with a proven ability to teach and motivate students to maximum performance by maintaining a positive and energetic environment.

Skills

Knowledge of physics and astronomy principles and laws.
Strong communication and interpersonal skills.
Extremely comfortable working with diverse populations of students.
Excellence in understanding and instructing many different learning styles.

Proven ability to develop varied and alternative assessments so that all students have a way to express their mastery of a topic.
Strong ability to integrate technology into the learning environment through lecture and laboratory presentations.
Extensive knowledge of graphing calculators, Vernier calculator based laboratories, Vernier LabQuest, Smart technology, Microsoft Word, Excel, and PowerPoint applications, physics and astronomy-based simulation software.
Strong ability to work with colleagues to develop and implement academic and administrative changes.

Experience

Physics and Astronomy Instructor **Aug 2017-Present**

Fitchburg State University – Fitchburg, MA

- Prepare and deliver lectures to undergraduate students on topics in algebra-based physics courses.
- Prepare and deliver lectures to undergraduate students on topics in introductory astronomy courses.
- Create and develop laboratory exercises to accompany lecture work in physics and astronomy courses.
- Evaluate and grade students' class work, laboratory work, assignments, and papers.
- Advise students on academic matters.

Physics Lab Instructor **Aug 2016-Aug 2017**

Framingham State University – Framingham, MA

- Prepare and deliver laboratory lectures to undergraduate students in calculus-based physics lab courses. Conduct demonstrations and evaluate student laboratory work.

Physics Instructor **Jan 2016-May 2016**

Manchester Community College – Manchester, CT

- Prepare and deliver lectures to undergraduate students on topics in algebra-based physics courses.
- Evaluate and grade students' class work, laboratory work, assignments, and papers.

Physics Instructor **Sep 2013-Present**

Three Rivers Community College - Norwich, CT

- Prepare and deliver lectures to undergraduate students on topics in calculus-based and algebra-based physics courses
- Evaluate and grade students' class work, laboratory work, assignments, and papers.

Physics Instructor **Jun 2014-Present**

Bristol Community College - Fall River, MA

- Deliver lectures and laboratories in physics, astronomy, and scientific ethics for students in the Upward Bound Summer Residential Program at Wheaton College, Norton, MA.

Physics Teacher **Sep 2009-May 2012**

The Kingswood Oxford School - West Hartford, CT

- Prepared and delivered lectures in Honors and Advanced Placement Physics, Mathematics, and Astronomy.
- Planned, evaluated, and revised curricula, course content, and course materials and methods of instruction.
- Advised students on academic and personal matters.
- Acted as adviser to multicultural student organization, UNITED STUDENTS.
- Coached junior varsity and varsity field hockey, girl's junior varsity basketball and tennis.

Physics Teacher **Sep 1999-May 2009**

The Pomfret School - Pomfret, CT

- Prepared and delivered lectures in Physics and Astronomy.
- Developed courses for the science department in the area of astronomy. Created Senior Exhibition of Mastery in Science program.
- Planned, designed, and equipped a state-of-the-art astronomical observatory for classroom instruction.
- Co-director for Multicultural Affairs.
- Acted as adviser to student diversity organization, VOICE.
- Served on academic and administrative committees that dealt with institutional policies, departmental matters, and academic issues.
- Advised students on academic and personal matters.
- Faculty member of discipline committee.

- Participated in student recruitment, registration, and placement activities.
- Coached varsity field hockey, and girl's varsity basketball team. 2002 basketball team was the Class C New England Prep School champion.

Mathematics and Science Teacher **Aug 1996-May 1999**
Heathwood Hall Episcopal School - Columbia, SC

- Prepared and delivered lectures in the mathematics and science curriculum.
- Advise student on academic and personal matters.
- Faculty adviser for Senior Exhibition committees.
- Adviser to student diversity council.
- Faculty sponsor for Les Savants Chapter of the National Honor Society.
- Athletic coach for varsity volleyball and girl's junior varsity basketball.

Mathematics and Physics Teacher **Aug 1987-May 1996**
The Tilton School - Tilton, NH

- Prepared and delivered lectures in various courses in the mathematics and science curriculum.
- Advised students on academic and personal matters.
- Assistant to the Dean of Students.
- Faculty member of the discipline committee.
- Faculty adviser to the multi-cultural student organization.
- Athletic coach for women's varsity basketball and field hockey teams.

Tutor/ Mathematics Instructor **Aug 1982-Aug 1987**
Quinsigamond Community College - Worcester, MA

- Prepared lesson plans or learning modules for tutoring sessions according to students' needs and goals.
- Provided private instruction to individual or small groups of students to improve academic performance, improve occupational skills, or prepare for academic or occupational tests.
- Developed teaching or training materials, such as handouts, study materials, or quizzes.
- Prepared and delivered lectures for various mathematics courses.
- Instructed physics and physical science laboratory courses. Built and maintained laboratory equipment.

Education

Master of Science: **Astronomy** **Mar 2010**
James Cook University - Townsville City, QLD

Bachelor of Science: **Mathematics/Physics** **May 1978**
Keene State College - Keene, NH

Reid Allen Parsons

34 Jenks St.
Amherst, MA 01002 rparson4@fitchburgstate.edu

Education

2010 **Ph.D., Earth Science (Planetary Science)**, University of California, Santa Cruz
Thesis Topic: Recent climate change on Mars (advisor: F. Nimmo)

2005 **B.S., Science of Earth Systems**, Cornell University (Magna Cum Laude with Distinction in Research)
Study Abroad: Earth and Environmental Science Hawai'i Field Program

Appointments

9/2013 - present **Assistant Professor**, Earth & Geographic Sci., *Fitchburg State Univ.*
9/2017 - 9-/2019 **Project Associate Research Professor**, University Museum, *Univ. of Tokyo*
*1/*2012 - 8/2013 **Postdoctoral Fellow**, *NASA Ames Research Center; Advisor: Dr. Jeff Moore.*
1/2011-12/2011 **Postdoctoral Researcher**, *UCSC; Advisor: Dr. Francis Nimmo*
1/2010-3/2010 **Instructor**, Planetary Discovery, *UCSC*
10/2008-11/2009 **Instructor**, Teaching Seminar, *UCSC*
4/2008-6/2008 **Teaching Assistant**, Geomorphology, *UCSC*
1/2006 - 3/2007 **Teaching Assistant**, Planetary Discovery, *UCSC*
6/2004-8/2004 **Undergraduate Research Assistant**, Univ. of Minnesota, *Minneapolis, MN*
4/2004 **GIS Volunteer**, Natural Resource Conservation Service, *Waimea, HI*
5/2003-8/2003 **GIS Technician**, Bureau of Land Management, *Meeker, CO*

Awards/Contributions

2018 Voting member: NASA's Mars Data Analysis Program grant selection panel.
2018 NASA Mars Data Analysis Program Grant (Co-I)
"Determining martian debris-covered glacier flow history from high-resolution morphology and flow modeling"
2016 & 2015 Fitchburg State Univ. Special Projects Grant Awardee
2015 NASA Mars Data Analysis Program Proposal Reviewer
2014 NASA Mars Data Analysis Program Grant (Co-I)
"A Coupled Geophysical and Modeling Analysis of Mid-Latitude Glaciers on Mars"
2013 Session Chair: Lunar and Planetary Science Conference, Houston, TX
2009 - pres. Reviewer for Journals: Icarus, Geophysical Research Letters, International Journal of Glaciology
2009 NSF Doctoral Dissertation Enhancement Program Grant
2009 Center for the Origin, Dynamics, and Evolution of Planets Travel Grant
2008 Water's Award (for best yearly Ph.D. thesis proposal in Earth & Planetary Sciences Dept, UCSC)
2005 Distinguished Undergraduate Researcher, Cornell University

Membership in Professional Associations

2004 - present American Geophysical Union Member
2004 - present Geological Society of America

Professional Development

2014 Exploring ENVI : Training course on the ENVI Software package for Remote Sensing image analysis hosted by the developer, Exelis Vis in Boulder, CO (Oct. 14 - 16)

2014 Workshop of Early Career Geoscience Faculty (sponsored by On the Cutting Edge; National Association of Geoscience Teachers), held in College Park, MD (June 22 - 26)

Courses Taught @ Fitchburg State Univ.

Earth Systems Science
Geology (LAB)
Environmental Geology
Honors Seminar in Environmental Science
Planetary Atmospheres
Planetary Science
Geomorphology (LAB)
Remote Sensing
Geographic Perspectives on Conservation

Courses Taught @ UCSC

Planetary Discovery
Teaching Seminar (TA training)

Peer-Reviewed Publications in Professional Journals

Parsons, R.A., T. Kanzaki, R. Hemmi, and H. Miyamoto, (2020) *Cold-based glaciation of Pavonis Mons, Mars: Evidence for moraine deposition during glacial advance,* Progress in Earth and Planetary Science, Vol. 7, 13. https://doi.org/10.1186/s40645-020-0323-9 **(open access)**

Hemmi, R., H. Miyamoto, and R.A. Parsons (2018), *Geological activities on present-day Mars and implications for future Mars missions* [in Japanese]. Planetary People, 27(3), 152-162.

Parsons, R.A. and H. Miyamoto, (*2018) Optimizing Change Detection for Planetary Remote Sensing Datasets,* Journal of Physics: Conf. Series 1036 (012004), September 10–13, 2017, Kyoto, Japan.

Parsons, R.A. and J. W. Holt (2016) *Constraints on the formation and properties of a Martian lobate debris apron: Insights from high-resolution topography, SHARAD radar data, and a numerical ice flow model*. Journal of Geophysical Research: Planets, Vol.121, doi: 10.1002/2015JE004927.

Parsons, R.A., J.M. Moore, and A.D. Howard (2013). *Evidence for a short period of hydrologic activity in Newton crater, Mars, near the Hesperian-Amazonian transition*. Journal of Geophysical Research: Planets, Vol. 118, 1-12, doi:10.10002/jgre.20088.

Parsons, R.A., F. Nimmo, and H. Miyamoto, (*2011). Constraints on martian lobate debris apron evolution and rheology from numerical modeling of ice flow,* Icarus*, Vol. 214,* pp. 246-257, *doi:10.1016/j.icarus.2011.04.014*.

Parsons, R.A. and F. Nimmo, (2010) *Numerical modeling of Martian gully sediment transport: Testing the fluvial hypothesis*, Journal of Geophysical Research: Planets*,* Vol. Vol. 115, doi:10.1029/2009JE003517.

Parsons, R.A. and F. Nimmo, (2009) *North-south asymmetry in martian crater slopes*, Journal of Geophysical Research: Planets, Vol. 114 ,doi:10.1029/2007JE003006.

Parsons, R.A., F. Nimmo, J. W. Hustoft, B. K. Holtzman, D. L. Kohlstedt, (2008) *An experimental and numerical study of surface tension-driven melt flow*, Earth and Planetary Science Letters, 267, pp. 548-557.

Invited Talks

Cold-based glaciation at Pavonis Mons, Mars: Evidence for moraine deposition during glacial advance, Japan Geoscience Union, May 2019, Chiba, Japan.

Predicted Flow Rates for Martian Mid-latitude Ice Deposits, Japan Geoscience Union, May 2018, Chiba, Japan.

Optimizing Change Detection for Planetary Remote Sensing Datasets, High-Dimensional Data-Driven Science Conference, Sept. 2017, Kyoto, Japan.

Climate Change on the Red Planet, Public Talk, Sept. 2016, Fitchburg State University, MA, USA.

Water in the Middle of Martian History: Evidence from glaciers and stream-cut valleys, Institute of Geophysics and Planetary Physics Seminar, Feb. 2013, Univ. of California, Santa Cruz, USA.

Young fluvial valleys on Mars: constraining the water source using quantitative geomorphology, Division of Geological and Planetary Sciences: Kliegel Lectures in Planetary Sciences, April 2012, California Institute of Technology, Pasadena, CA, USA.

Numerical modeling of Martian gully sediment transport: Testing the fluvial hypothesis, American Geophysical Union Fall Meeting, Dec. 2009, San Francisco, CA, USA.

Where is Mars' Ice? Constraints from impact craters and lobate debris aprons on a mid-latitude reservoir, Search for Extra-Terrestrial Intelligence: Public Talks, Sept. 2009, Mountain View, CA, USA.

Thick ice deposits at mid-latitudes on Mars, Seminar at the Earthquake Research Institute, July 2009, University of Tokyo, Japan.

Oral Presentations @ Lunar and Planetary Science Conference, Houston, TX, USA

2019 *Cold-based Glaciation and Moraine Deposition at Pavonis Mons, Mars*
2016 *Evidence for Variable Ice Accumulation or Viscosity of Martian Glaciers on Opposing Slopes of Euripus Mons, Mars from Numerical Ice Flow Modeling*
2014 *Determining the Age and Physical Properties of Martian Lobate Debris Aprons using High-resolution Topography, SHARAD Observations, and Numerical Ice Flow Modeling: A case study at Euripus Mons*
2013 *Glaciation at Euripus Mons, Mars: Insights from combining numerical ice flow modeling, SHARAD observations and high-resolution topography*
2009 *Fluvial discharge rates of Martian gullies: Slope measurements from stereo HiRISE images and numerical modeling of sediment transport*
2008 *Martian gully slope measurements made using HiRISE stereo pairs*
2007 *North-south asymmetry in Martian crater slopes*

Poster Presentations

@ Japanese Geophysical Union Meeting, Makuhari Messe, Chiba, Japan

5/2019 Detecting surface changes on Mars using principle component analysis of repeat imagery

@ Lunar and Planetary Science Conference, Houston, TX, USA

3/2018 Influence of Debris Cover on the Temperature of Buried Martian Ice Deposits

@ American Geophysical Union Fall Meeting, San Francisco, CA, USA

2010 Constraints on lobate debris apron evolution and rheology from numerical modeling of ice flow

2005 Surface Tension-Driven Melt Flow in the Upper Mantle: An Experimental and Modeling Approach to Studying Capillary Flow of Silicate Melt through an Olivine Matrix

Conference Abstracts:

Parsons, R.A..Finding the Ice's Bottom: Estimating Ice thickness using Basal Stress and Surrounding Topography in Martian Mid-latitude Ice Deposits, 51st Lunar and Planetary Science Conference, March 16-20, 2020, The Woodlands, TX.

J. S. Levy, W. Cipolli, Ishraque, F., M. Tebolt, C. I. Fassett, Parsons, R.A., & J. Holt. Boulder Bands on Lobate Debris Aprons: Does Spatial Clustering Reveal Accumulation History for Martian Glaciations?, 51st Lunar and Planetary Science Conference, March 16-20, 2020, The Woodlands, TX.

Parsons, R.A. R. Hemmi, Miyamoto, H., and T. Kanzaki. Cold-based Glaciation and Moraine Deposition at Pavonis Mons, Mars, 50th Lunar and Planetary Science Conference, March 18-22, 2019, The Woodlands, TX.

Parsons, R.A. and Miyamoto, H. Change Detection in Repeat Imagery Using Principle Component Analysis, 49th Lunar and Planetary Science Conference, March 19-23, 2018, The Woodlands, TX.

Parsons, R.A. Predicted Flow Rates for Martian Mid-latitude Ice Deposits, Proceedings of the Japan Geoscience Union Meeting, PPS07-09, May 20–24, 2018, Chiba, Japan.

Parsons, R.A. and Miyamoto, H. Influence of Debris cover on the Temperature of Buried Martian Ice Deposits, 49th Lunar and Planetary Science Conference, March 19-23, 2018, The Woodlands, TX.

Parsons, R.A. Optimizing Change Detection for Planetary Remote Sensing Datasets, Proceedings of the International Meeting on "High-Dimensional Data-Driven Science" (HD3-2017) September 10–13, 2017, Kyoto, Japan

Parsons, R.A.; Holt, J. W., Evidence for Variable Ice Accumulation or Viscosity of Martian Glaciers on Opposing Slopes of Euripus Mons, Mars from Numerical Ice Flow Modeling. 47th Lunar and Planetary Science Conference, The Woodlands, TX, March, 2016; Abstract #1462.

Petersen, E. I.; Holt, J. W..; Parsons, R.A.; Levy, J. S.; McKinnon, E.A. Regional Variations in Martian Debris-Covered Glaciers Understood through Flow Modeling and Multifaceted Data Analysis. 46th Lunar and Planetary Science Conference, The Woodlands, TX, March, 2015; Abstract #2253.

Petersen, E. I.; Holt, J. W.; Levy, J. S.; Parsons, R.A. A Synthesis of Radar Sounding, Geomorphic Characterization, and Ice Flow Modeling to Understand Regional Differences between Lobate Debris Aprons in Deuteronilus Mensae. 8th Mars Conference, Pasadena, CA, July 2014; Abstract #1451.

Parsons, R.A.; Holt, J. W., Determining the Age and Physical Properties of Martian Lobate Debris Aprons using High-resolution Topography, SHARAD Observations, and Numerical Ice Flow Modeling: A case study at Euripus Mons, 45th Lunar and Planetary Science Conference, The Woodlands, TX, March, 2014; Abstract #1484.

Barnhart, C. J.; Parsons, R.A.; Benson, S. M., Potential Coastal Pumped Hydroelectric Energy Storage Locations Identified using GIS-based Topographic Analysis, American Geophysical Union Fall Meeting, San Francisco, CA, Dec, 2013; Abstract H21J-1208.

Parsons, R.A.; Holt, J. W., Glaciation at Euripus Mons, Mars: Insights from Combining Numerical Ice Flow Modeling, SHARAD Observations and High-Resolution Topography, 44th Lunar and Planetary Science Conference, The Woodlands, TX, March, 2013; Abstract #1840.

Morgan, A. M.; Howard, A. D.; Hobley, D. E. J.; Matsubara, Y.; Moore, J. M.; Parsons, R.A.; Williams, R. M. E.; Burr, D. M.; Hayes, A. G.; Dietrich, W. D, Alluvial Fans of Northern Chile as an Analog to Mars, 44th Lunar and Planetary Science Conference, The Woodlands, TX, March, 2013; Abstract #2833.

Moore, Jeffrey M.; Howard, A. D.; Parsons, R.A.; Hobley, D. E. J., Hesperian-Amazonian Transition Mid-latitude Valleys: Markers Of A Late Martian Climate Optima? American Astronomical Society, DPS meeting #44, #404.06

Parsons, R.A.; Moore, J. M.; Howard, A. D., Water Volume and Timescale Estimates for Valley Formation During the Late Hesperian to Early Amazonian, Mars, Comparative Climatology of Terrestrial Planets, held June 25–28, 2012, in Boulder, Colorado.#1675.

Parsons, R.A. Moore, J. M.; Howard, A. D., Hydrology of Hesperian/Amazonian-Aged Valleys in Newton Basin, Mars: How Much Water for How Long? 43rd Lunar and Planetary Science Conference, held March 19–23, 2012 at The Woodlands, Texas. #1659.

Parsons, R.A., F. Nimmo, and H. Miyamoto, Constraints on lobate debris apron evolution and rheology from numerical modeling of ice flow, American Geophysical Union Fall Meeting, San Francisco, CA, Dec, 2010; Abstract EP41B-0695.

Parsons, R.A., F. Nimmo, and H. Miyamoto, Constraining the timing of lobate debris apron emplacement at Martian mid-latitudes using a numerical model of ice flow, 41st Lunar and Planetary Science Conference, Houston, TX, March, 2010; Abstract #1463.

Parsons, R.A. and F. Nimmo, Numerical modeling of Martian gully sediment transport: Testing the fluvial hypothesis (Invited), American Geophysical Union Fall Meeting, San Francisco, CA, Dec, 2009; Abstract EP53F-04.

Parsons, R.A. and F. Nimmo, Fluvial discharge rates of Martian gullies: Slope measurements from stereo HiRISE images and numerical modeling of sediment transport, 40th Lunar and Planetary Science Conference, Houston, TX, March, 2009; Abstract #1947.

Parsons, R.A., F. Nimmo, and M. Kreslavsky, Fluvial discharge rates of Martian gullies: Slope measurements from stereo HiRISE images and numerical modeling of sediment transport, American Geophysical Union Fall Meeting, San Francisco, CA, Dec, 2008; Abstract P41A-1350.

Parsons, R.A. and F. Nimmo, Martian gully slope measurements made using HiRISE stereo pairs, 39th Lunar and Planetary Science Conference, Houston, TX, March, 2008; Abstract #2328.

Parsons, R.A. and F. Nimmo, North-South Asymmetry in Martian Crater Slopes, American Geophysical Union Fall Meeting, San Francisco, CA, Dec, 2007; Abstract P33A-1019.

Parsons, R.A., F. Nimmo, and M. D. Ellehoj, North-South Asymmetry in Martian Crater Slopes, Seventh International Conference on Mars, Pasadena, CA, July, 2007; Abstract #3359.

Parsons, R.A., F. Nimmo, and M. D. Ellehoj, North-South Asymmetry in Martian Crater Slopes, 38th Lunar and Planetary Science Conference, Houston, TX, March, 2007; Abstract #2108.

Parsons, R.A., J. W. Hustoft, B. K. Holtzman, D. L. Kohlstedt, and F. Nimmo, Surface Tension-driven Melt Flow in the Upper Mantle: An Experimental and Modeling Approach to Studying Silicate Melt Diffusion Through an Olivine Matrix, 37th Lunar and Planetary Science Conference, Houston, TX, March, 2006; Abstract #2446.

Hart, S. D., V. C. Gulick, S. T. Ishikawa, C. J. Barnhart, and R. A. Parsons, Detailed Topographic and Morphometric Analysis of Lyot's Central Peak Gullies, 41st Lunar and Planetary Science Conference, Houston, TX, March, 2010; Abstract #2662.

Hart, S. D., V. C. Gulick, R. A. Parsons, and C. J. Barnhart, Gully Slopes and Discharges on Lyot Crater's Central Peak, 40th Lunar and Planetary Science Conference, Houston, TX, March, 2009; Abstract #2349.

Irwin, R. P., C. M. Fortezzo, S. E. Tooth, A. D. Howard, J. R. Zimbelman, C. J. Barnhart, A. J. Benthem, C. C. Brown, R. A. Parsons, Origin of Theater-Headed Tributaries to Escalante and Glen Canyons, Utah, 40th Lunar and Planetary Science Conference, Houston, TX, March, 2009; Abstract #1644.

Hart, S. D., R. A. Parsons, C. J. Barnhart, and V. C. Gulick, Central Peak Gully Formation and Morphologies on Mars, American Geophysical Union Fall Meeting, San Francisco, CA, Dec, 2008; Abstract P41A-1348.

Irwin, R. P., C. M. Fortezzo, S. E. Tooth, A. D. Howard, J. R. Zimbelman, C. J. Barnhart, A. J. Benthem, C. C. Brown, R. A. Parsons, Origin of Theater-Headed Tributaries to Escalante and Glen Canyons, Utah: Analogs to Martian Valley Networks, American Geophysical Union Fall Meeting, San Francisco, CA, Dec, 2008; Abstract P41A-1351.

JIANG YU, Ph.D.
Fitchburg State University
Fitchburg, MA 01420
Tel: 978-665-3380, Email: jyu@fitchburgstate.edu

POSITION

Professor of Physics, Physics, Fitchburg State University, Massachusetts, USA

EDUCATION

- Ph.D., Science Education (Concept Learning & Development in Physics), 1995, Western Michigan University, Kalamazoo, MI
- M.S., Physics (Theoretical Nuclear Physics), 1988, Western Michigan University, Kalamazoo, MI
- B.S., Physics (Particle Physics), 1983, University of Science and Technology of China, Hefei, Anhui, China

TEACHING

Professor of Physics, Fitchburg State University, Massachusetts, September 2008 – present.
Associate Professor of Physics, Fitchburg State University, Massachusetts, September 2002 – August 2008.
Assistant Professor of Physics, Fitchburg State University, Massachusetts, September 1996 – August 2002.
Adjunct Instructor (Physics), Physics Department, Western Michigan University, Kalamazoo, Michigan, 1986 – 1996.
Adjunct Instructor (Physics), Kalamazoo Valley Community College, Kalamazoo, Michigan, 1988 –1996.
Lecturer (Physics), Physics Department, Tibetan University, Lhasa, Tibet, 1983 – 1986.

SERVICE TO PROFESSIONAL ORGANIZATION

Judge and Board member of the United States Invitational Young Physicists Tournament (USIYPT), January 2014 - present

SERVICE TO THE COLLEGE BOARD AP PHYSICS PROGRAM

Member of the AP Physics Course Audit Scoring Guide Development Committee, February 2019 – March 2020
Curriculum Adviser & Senior Reviewer for the AP Physics Course Audit Program, Educational Policy Improvement Center at the University of Oregon, June 2008 – present
College Board Endorsed AP Physics Workshop Consultant, August 2005 – present
Chief Reader Associate, AP Physics Exam Reading, College Board/Educational Testing Services, July 2013 – June 2017
Chief Reader for the AP Physics Exam Reading, College Board/Educational Testing Services, July 2009 – June 2013
Chief Reader Designate for the AP Physics Exam Reading, CB/ETS, July 2008 – June 2009
Question Leader for the AP Physics Exam Reading, CB/ETS, June 2006 - June 2008
Table Leader for the AP Physics Exam Reading, CB/ETS, June 2003 – June 2005
AP Physics Exam Reader for the AP Physics Exam Reading, CB/ETS, June 2000 – June 2002
Member of the Physics 1 & Physics 2 Course Audit Standard Setting Committee, College Board, July 2012 – May 2014
Member of the AP Annual Conference Steering Committee, August 2010 – July 2013

WORKSHOPS GIVEN AND ONGOING

AP Physics Summer Institutes (week-long): Numerous Physics 1, Physics 2, and Physics C are delivered over the years, beginning in 1998 at Fitchburg State University. In the lately ten years, every summer 4 to 7 are delivered at various universities and schools in the US. One international institute was delivered in Abu Dhabi, UAE.
AP Physics One- or two-day Workshops: Numerous are given each year for the College Board as its endorsed AP workshop consultant, including national and international workshops outside of the USA. Also delivered workshops for NMSI member organizations such as Massachusetts Math & Science Initiative, A+ College Ready (Alabama), and Advance Kentucky.
AP Students Sessions: Numerous Saturday sessions are given for MMSI in Massachusetts and NMSI outside of Massachusetts.
Other non-AP Physics or physical science teacher workshops

PRESENTATION

Results of the AP Physics Exam Administration. AP Annual Conference, July, 2013 (Las Vegas, NV), 2012 (Orlando, FL), 2011 (San Francisco, CA), 2010 (Washington D.C.).
AP Physics Programs and Examinations, AP Affair, Shenzhen, China, March 6-8, 2011
Examination of the Massachusetts Science and Technology/Engineering Curriculum Framework Using GSL Objectives. The 3rd Annual Hawaii International Conference on Education, Honolulu, Hawaii, Jan. 3 – 7, 2005
An Inventory of Algebra, Trigonometry, and Analytical Geometry for Algebra/Trig Based College Introductory Physics Course, Williamston, MA, April 11-12, 2003
Conceptual oriented college introductory physics teaching: gains and recommendations. The XVIII GIREP Conference: PHYTEB2000, Barcelona, Spain, Aug. 27 – Sept. 1, 2000.
Teaching Physical Science To Pre-Service Elementary Teachers: An AAPT Model Course Developed Based On Physics Education Research. American Association of Colleges and Universities Conference: Rethinking Scientific Literacy in an Age Of Diversity And Specialization, Charleston, SC, April 13-15, 2000

PROFESSIONAL DEVELOPMENT

College Board Consultant Training, "AP Physics Summer Institutes" Fort Worth, TX, January 26-27, 2019
College Board Consultant Training, "AP Physics 1 & 2: Guided Inquiry Labs ," Chicago, IL, April 5-6, 2014
College Board Consultant Training, "AP Physics 1 & 2: Building Students' Reasoning Skills," Las Vegas, NV, Aug. 3-4, 2013
College Board AP Physics 1 & 2 Consultant Training: Framework & Course Description," Chicago, IL, April 19-21, 2013
College Board 2009-2010 Mentor Initiative, Henderson, NV, Aug. 6-9, 2009
TI-Nspire Conference for the College Board Consultants held by the Texas Instruments at Dallas, TX, Nov. 16 – 18, 2007.
College Board Consultant Training, Charlotte, NC, April 8-10, 2005
The Commonwealth Information Technology Initiative (CITI) workshop, "OBJECT ORIENTED DESIGN & ANALYSIS," Worcester State College, MA, June 2, 3, 9, 10, 2001.
Certificate, AAPT/NSF workshop, "Just in Time Teaching," AAPT/NES 1999 Fall Meeting at Norwich University, North Field, Vermont, November 5, 1999.
Certificate, NSF college faculty summer workshop, "Innovative Physics Experiments Workshop," Winston-Salem State University, Winston-Salem, North Carolina, July 26-31, 1998.
Certificate, NSF Chautauqua short course, "Promoting Active Learning in Introductory Physics Courses I," Honolulu, Hawaii, June 9-11, 1998.
Certificate, AAPT/NSF summer faculty enhancement workshop, "Powerful Ideas in Physical Science: A Model Course," Louisiana State university, Baton Rouge, Louisiana, May 24 - June 5, 1998

RESEARCH

Global Science Literacy, Geo/Physical Science Dept., Fitchburg State University, 1999 – 2003
Concept learning/conceptual change in physics learning, Center for Science Education, Western Michigan University, 1988 – 1996
Theoretical nuclear physics, shell model, Physics Department, Western Michigan University, 1986 – 1988
Higher energy physics, cosmic-ray physics, High Energy Physics Institute, Chinese Academy of Sciences, Beijing, China & Physics and Mathematics Department, Tibetan University, 1984 – 1986
Heavy-atomic experimental nuclear physics, Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, China, 1983

PUBLICATION

Yu, J. (2005). Examination of the Massachusetts Science and Technology/Engineering Curriculum Framework Using GSL Objectives, in *Proceedings of the 3rd Annual Hawaii International Conference on Education.* Honolulu: CD Production.
Yu, J. (2003). The application of GSL philosophy to science education in the People's Republic of China, in Mayer, V. (ed.), *The Applications of Global Science Literacy*. Columbus: The Ohio State University Press.
Yu, J. (2001). Conceptual oriented college introductory physics teaching: gains and recommendations, in Pints, R., & Suriqach, S. (eds.), *International Conference Physics Teacher Education Beyond 2000: Selected Contributions*. Paris: Elsevier Editions. Also in Pints, R., & Suriqach, S. (eds.), *Proceedings of the International Conference Physics Teacher Education Beyond 2000*. Barcelona: CD Production Calidos.
Halderson, D., Yu, M., and Yu, J. (1989). Structure of the first excited state of He(4), *Physical Review C*, vol. 39, no. 2.

Appendix G. Annual departmental budget fiscal years 2015-20.

Year	E00	F00	J00	K00	L00	M00	U00	Total
2015	$750.00	$500.00	0	$7250.00	0	$200.00	$800.00	$9500.00
2016	$975.00	$2000.00	0	$5250.00	0	$200.00	$800.00	$9500.00
2017	$926.25	$1900.00	0	$5248.75	0	$190.00	$760.00	$9025.00
2018	$600.00	$4475.00	$300.00	$3000.00	$200.00	$250.00	$200.00	$9025.00
2019	$600.00	$4475.00	$300.00	$3000.00	$200.00	$250.00	$200.00	$9025.00
2020	$600.00	$4475.00	$300.00	$3000.00	$200.00	$250.00	$200.00	$9025.00

Budget categories are as follows: E - administrative expenses, F - Facility operations (e.g., lab supplies); J – Operational expenses; K – Equipment purchase; L – Equipment repair; M – Student travel; U – Information Technology

Appendix H. Equipment, materials, and technology

I. Technology

a. Hardware

All faculty have university-issued HP or Mac Laptops with docking stations.
Additional HP computers are located in SCI317 for Geospatial Research (Huang)
iMac and Linux machines in SCI319 for Mars research (Parsons)
Mac Minis w/HP monitors in physics labs (student use)

b. Software

The Technology Department maintains licenses for industry-standard software for geospatial analysis: ArcGIS, ArcPro, and ENVI. The software can be accessed from the department's computer lab (SCI127), and students are able to access the server remotely using VMWare. Virtual Astronomy, used by Astronomy students, is also loaded onto this server.

2. Earth Science teaching equipment includes:
10x hand lenses, Silva compasses, Brunton compasses, Optical range finder, Abney level, Brunton tripods, Silva Teaching Aids, Rock hammers, Sledge hammers, Cold chisels, Sample bags, Drawing compasses, Digital calipers, Hubbard sun scale , binocular microscopes, triple beam balances, weight sets, transverse wave demonstrators, refractometers, hydrometers , thermometers, pH testers, sedimentators, Ohaus digital analytical balance, Ohaus field digital balance, solar radiation kits, ring stands, plastic sample tubes, hot plates, porosity, permeability hardware, assorted glassware and plasticware, sieves, weather meters, sling psychrometers, solar lab materials, high quality anemometer, digital flow meter, field rain gauge, soil thermometer, hygrometer, trundle wheel, Coriolis demonstrator, seismograph model, various rocks, mineral kits, density equipment, radioactive decay lab equipment (not radioactive), dendrochronology lab equipment, contour models, air pressure demonstrator, barycenter, capilary tube demonstrators, wave tanks, slinkies; Water level (100m), bailer, auger kit, HOBO water level and barometric loggers

3. Geographic science and map materials
GPS units: 24 Garmin eTrex Summits
Departmental Map Library of more than 500 maps (SCI124)
Army map reading materials, Earth Science Curriculum Project (ESCP) globes, Map projection models, Earth globes, Fitchburg quad 1988 maps, USGS topographic map pamphlets, USGS topographic map symbol pamphlets, miscellaneous maps, physiographic maps (several of different areas), stereo atlases, anaglyph book, landform feature books, stereo pair viewers, geoscopes, land use maps,

4. Astronomy materials
Two planet planetarium, star globes, moon globe, Edmund star finder, star globes, Solarscope, homemade parallax equipment, astrolabes

4. Physics equipment and materials

air supplies (4) (E, 3)
air tracks
assorted bar magnets
assorted capacitors
assorted clamps and bars
assorted low pressure spectrum tubes
assorted multimeters (15)
assorted old ammeters
assorted optics
assorted resistors
assorted tuning forks
Beck ballistic pendula (5)
Beck centripetal apparatus (8)
brand x air supply (1)
breadboards (8)
Cenco electric field plates (9)
Coulomb's Law apparatus (8) (A, 4)
diverse capacitors
diverse elementary optics
diverse large masses (four 2k, five 5k, two 1k)
diverse wires
Energizer recharger
Extech DC power supplies (8)
Extech DC power supply (24)
Fluke multimeters
force tables (8)
Foucault pendulum demonstrator
Pasco timer switch
Pasco voltage sensors
Radio Shack electret condenser microphones (8)
Ripple tank
Sargent Welch 75W AC/DC power supplies (9)
Savart's toothed wheel (for sound demonstration) (1)
compasses of diverse sizes
slinkies (5)
small scales (3 boxes)
spectrometers
spectrum tube power supplies
General vernier calipers (10)
HeNe lasers
hooked masses (7 sets)
hot plate (1)
inclined planes and potential to kinetic energy demonstrators
interferometer
large concave mirrors (2)
large display galvano-voltmeter
levels (11), plus angle finder (2)
long, narrow spring (2)
Ohaus triple beam balances
old mechanical calipers (9)
optics benches, short & long paired
Overbeck field mapping assembly (10) (A, 3)
Overbeck field mapping assembly (6)
Pasco air supplies
Pasco air tracks
Pasco ballistic pendula
Pasco basic optics kits (8)
Pasco basic optics light source
Pasco basic optics ray table (5)
Pasco basic optics system (24)
Pasco basic optics, ray optics
Pasco calorimeters
Pasco Coulomb's Law apparatus
Pasco drop box
Pasco free fall adapters
stands and rods
stopwatches (9)
strobe light
sundry capacitors
sundry gliders
tall ring stands (7)
thermodynamic kits (4)
Ward's spectrum tube power supply (16) (B, 2 and 3)
Westward vernier caliper (1)
Radio Shack soldering gun
Radio Shack helping hands w/magnifier
Radio Shack rosin soldering flux
Pasco free fall balls acc.
Pasco function generators
Pasco high current sensor (7)
Pasco Interface 750 (9)
Pasco Interface 850 (8)
Pasco intro. rotational app. (8)
Pasco mass and hanger sets
Pasco mechanical vibrators (8)
Pasco mechanical wave driver
Pasco optics parts
Pasco optics ray tables
Pasco optics viewing screens
Pasco photogate head
Pasco photogate mounting brackets
Pasco photogate pulley system
Pasco resonance tubes
Pasco ring launcher (1)
Pasco RLC network
Pasco rotational motion apparatus (many
Pasco shoot the target accessory
Pasco sound sensors
Pasco stopwatches
Pasco table clamps
Pasco targets
Pasco temperature sensors
Pasco time of flight and accessories

Radio Shack cushion feet
Radio Shack tip tinner & cleaner wire
Kelvin multimeter (2)
diverse tools (Craftsman)

Appendix I. Library

FITCHBURG STATE UNIVERSITY
AMELIA V. GALLUCCI-CIRIO LIBRARY

To: Earth and Geographic Sciences Faculty
From: Jacalyn Kremer, Dean of Amelia V. Gallucci-Cirio Library
Renée Fratantonio, Instruction & Research Services Librarian
CC: Alberto Cardelle, Provost
John Schaumloffel, Dean of Health and Natural Sciences
Date: December 16, 2019
Re: Library resources and services support for **Earth and Geographic Sciences** program [DRAFT]

The New England Commission on Higher Education's Standard 7.22 calls for "access to library and information resources, services, facilities, and qualified staff sufficient to support its teaching and learning environments and its research and public service mission as appropriate." The purpose of this DRAFT report is to outline the current Amelia V. Gallucci-Cirio Library's resources, services and facilities that support the undergraduate programs in Earth and Geographic Sciences at Fitchburg State University. After review of the data compiled for this report, the library resources and facilities are sufficient to meet the needs of undergraduate researchers in Earth and Geographic Sciences and to support faculty in their teaching. That said, we would like to discuss increasing library research support through information literacy classes, particularly in courses with intensive research requirements. Only one research session was taught for Earth and Geographic Sciences courses in the last academic year; this course was part of the Summer Research Collaborative work on the Nashua River. There were no Earth and Geographic Sciences classes that had an embedded librarian in it. We also would like to learn more from you about what resources you and your students need that the library could provide. In addition, we hope to talk about how to increase Reserves check-outs and increase access to no or low cost resources for Earth and Geographic Sciences students.

ABOUT Earth and Geographic Sciences at Fitchburg State University

Students with (first) major as Earth and Geographic Sciences enrolled in Fall 2018	35

An analysis of the library support needed for the Earth and Geographic Sciences undergraduate major as well as undergraduates taking Earth and Geographic Sciences courses as non-majors are classified into three categories: resources, services and facilities.

RESOURCES for Earth and Geographic Sciences

Researchers in Earth and Geographic Sciences use academic journals, monographs (books), and governmental sources as well as NGO information.

1. Journals and Databases

The Amelia V. Gallucci-Cirio Library offers access to over 100,000 online journals in over 165 databases. Specifically for the Earth and Geographic Sciences major and classes, the Library purchases the databases EBSCO's GeoRef, GreenFile, Environmental Studies and Policies, and ProQuest Science. The library also purchases access to supplemental databases including A-Z Maps, Science and Technology Collection, SpringerLink, and Science in Context in addition to JSTOR Arts & Sciences Collection that includes 196 journal titles in subjects related to Environmental and Earth Sciences. See Library Table 1: Full-text Journal Databases by Disciplines related to Earth and Geographic Sciences**.** Statistics show the overall usage numbers are generally declining.

In Fall 2018, the library conducted a journal review project. It looked at the approximately 400 print and online journals to which the library subscribes (outside of the journals available through the databases). The library determined the annual cost per usage by dividing the annual cost for the journal title by the number of times the journal was used in a year. Criteria was established and applied that allowed the library to cancel journals that were not being effectively used. Three journals related to the Earth and Geographic Sciences area were canceled due to low usage: Astronomy (print cancelled, still available electronically), Science (print cancelled, still available electronically) and Weatherwise (canceled print and electronic, still available electronically with an 18 month embargo). This journal review project allowed the library to increase journal offerings in needed areas as determined by interlibrary loan data as well as to purchase large, multi-disciplinary eBook collections. More information about the new eBook collection is below.

The library collection development policy has been, and continues to be, to provide the core journals and databases appropriate for each discipline. Reviews of databases and journals are consulted, peer comparisons are conducted, and faculty input on the effectiveness of the resource is critical when considering new databases. Funds for new databases and/or journals are then requested, and if granted, they are purchased.

2. **Books**

A review of our print collection in the Library of Congress call number ranges specifically associated with Earth and Geographic Sciences shows over 5,000 print books in our collection. This is below an adequate depth of collection. See Library Table 2: Monograph Collection Description and Analysis.

In addition, almost all the books were in the print collection as the Library offered few eBooks. It was our recommendation that an eBook package that includes Earth and Geographic Sciences books be acquired to meet the needs of the undergraduate researcher and the faculty**.** This would not only increase the number of volumes available, it would also increase the number of books published in the past 5 years. Therefore, effective March 2019, the EBSCO Academic Complete eBook package was subscribed to that included approximately 7,852 Earth and Geographic Sciences related eBooks to meet the needs of the undergraduate researcher and the faculty**;** 1,096 of these eBooks were published in the last 5 years and 3,784 were published in the past 10 years. In addition to this, we also added the JSTOR EBA and DDA eBook collections which included 1,459 Earth and Geographic Sciences related eBooks; 527 of these were published within the last 5 years and 908 were published within the last 10 years. This increases the number of books associated with Earth and Geographic Sciences in total to **14,365** books while providing off-campus access. This total number brings the collection well above the level for lower level undergraduates (8,000-12,000 books) to the intermediate support level (12,000+ books).

3. Governmental and non-governmental (Gray) Literature and Data Sets

Vital data sets for Earth and Geographic Sciences are provided by United States governmental agencies, state and international government sites. Core data set resources are freely available, for example, at websites from the U.S. Geological Survey (USGS), National Center for Environmental Health (NCEH), and the Environmental Protection Agency (EPA). Massachusetts state environmental data is available freely online at Massachusetts Environmental Public Health Tracking. Other freely accessible data sources from other governmental agencies as well as non-profit sources are available.

Freely available datasets should adequately meet the needs of the undergraduate researcher.

4. Films and other Media

In 2018, the Library purchased a subscription to the academic streaming film database Kanopy. 3,985 videos are available with subjects aligned with Earth and Geographic Sciences (this includes some duplicates). See Library Table 3: Films and Other Media Collection for a breakdown by category.

SERVICES for Earth and Geographic Sciences

Library Instruction

For all academic departments in the 2019 academic year, faculty librarians taught 194 research sessions and were embedded into 72 courses. Through these efforts, we reached over 4,600 students during the last academic year. With only 6 faculty librarians on staff, the number of classes with research sessions and/or an embedded librarian is impressive and requests continue to increase.

One research session was taught for Earth and Geographic Sciences courses in the last academic year for the Summer Research Collaborative work on the Nashua River. There were no Earth and Geographic

Sciences classes that had an embedded librarian in it. The library would like to have conversations with Earth and Geographic Sciences faculty to explore how librarians can support the research needs of Earth and Geographic Sciences students through our research instruction program, particularly in research-intensive courses. For example, we recommend increasing library research support through information literacy classes aligned with courses with research requirements. See Library Table 4: Research Instruction for more information.

Library Research Guides

The Library offers 36 subject research guides plus 149 course specific guides, covering all disciplines at Fitchburg State. For Earth and Geographic Sciences, we have created 1 subject research guide and 2 course specific research guide. The usage statistics for the Earth and Geographic Sciences research guide show the guide was accessed 103 times in FY19. This is significantly lower than other library subject guides. Starting in Fall 2019, the Library's Earth and Geographic Sciences Research Guide was made available at point-of-need within the Blackboard course management system in all courses, including Earth and Geographic Sciences, in order to facilitate access. We expect usage to rise.

Research Help

The Library offers one-on-one reference services in a variety of modes, including dropping in at the reference desk, making a personal appointment, email, and chat instant messaging service. The overwhelming majority of such services are offered in-person at the research help desk, although this number has declined significantly over time. During the academic year, research help is available to students for 60 hours per week. The aggregate trends in research help appear in Library Table 5: Research Help. Statistics on the use of research help by Earth and Geographic Sciences students only are not available.

Reserves

The Library's Reserve system is well used by the Fitchburg State community. For example, this semester 98 professors put a total of 595 items on reserves. Checkouts of reserve materials by all students were more than 1,200 during the last academic year. During the current semester, Earth and Geographic Sciences faculty have put 7 items on reserve, although we do not see significant check-outs of those items. We hope to discuss with Earth and Geographic Sciences faculty further opportunities for Earth and Geographic Sciences faculty to utilize the Reserves program. In addition, the Library is currently exploring ways to increase access to materials by students, including the insertion of digital library resources into courses and the adoption of Open Educational Resources, which would increase student access to no or low-cost textbooks and other course materials.

Interlibrary Services Request

Data shows Earth and Geographic Sciences students and professors have almost no usage of Interlibrary Loan Services. As a department, they ranked well below average on their use compared to other departments. See Library Table 6: Interlibrary Services for details.

FACILITIES for Earth and Geographic Sciences

With the Library's recent renovation, students have access to welcoming spaces designed to support individual and group work. Building information is in Library Table 7: Facilities.

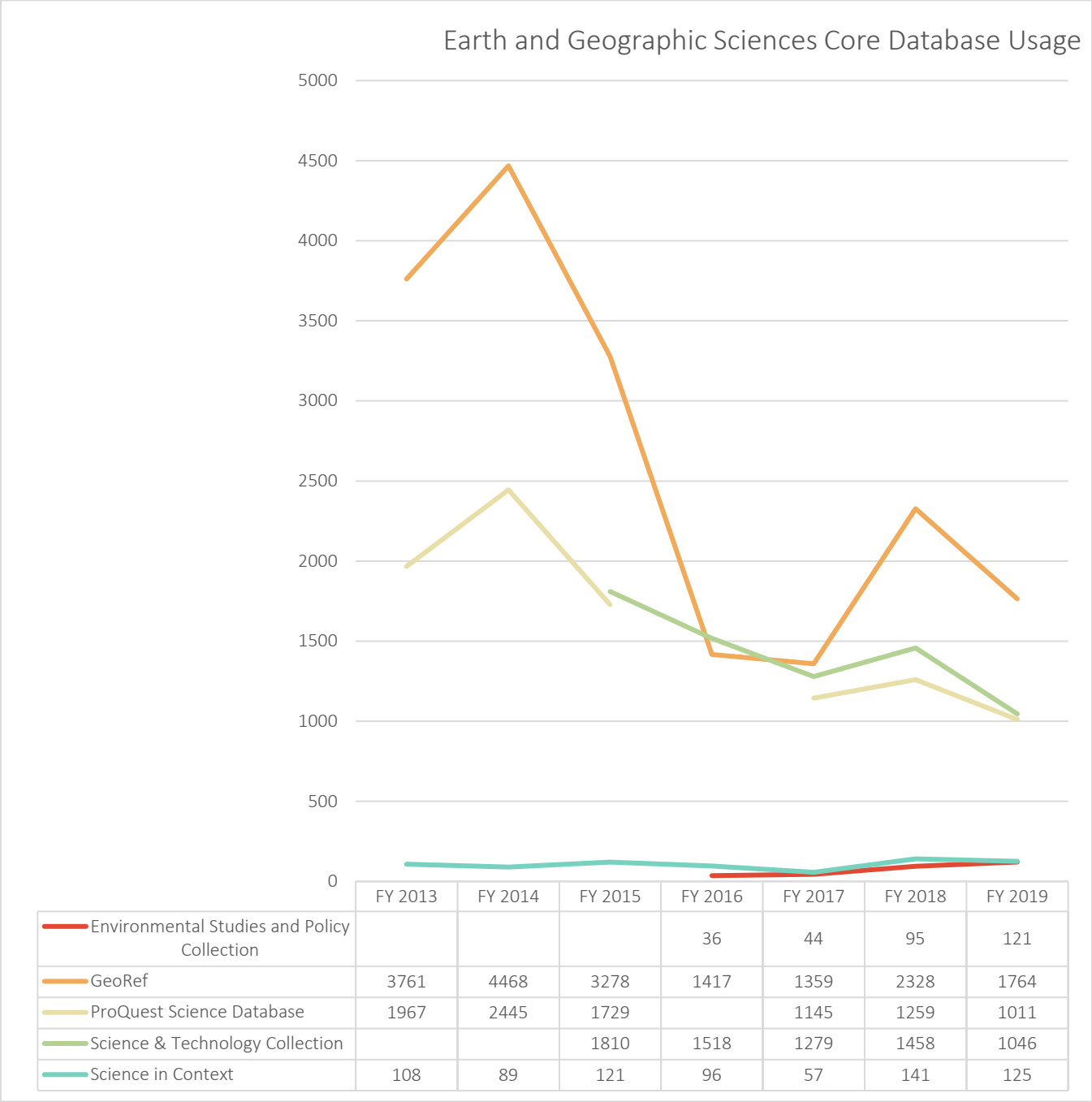
Library Table 1:

Full-text Journal Databases by Disciplines related to Earth and Geographic Sciences

The full complement of databases treating Earth and Geographic Sciences can be found on the library website (https://library.fitchburgstate.edu/research/databases/earth-geographic-sciences/). Whereas there are 11 directly applicable full-text databases, another 13 full-text databases supplement this core collection. In addition, individual journal titles that stretch across the disciplines and that are embedded within databases or that we subscribe to separately (and which are accessible through Serials Solutions) number in the thousands.

Core Full-text Journal Databases
1. A-Z Maps Online
2. Environmental Studies and Policy Collection
3. GeoRef
4. GreenFile
5. Open Science Directory (Open Access)
6. ProQuest Science Database
7. Science & Technology Collection
8. Science in Context
9. SpringerOpen
Supplemental Full-text Journal Databases
1. ABI/Inform
2. Academic OneFile
3. Academic Search Ultimate
4. Credo Reference
5. eBook Central (ProQuest)
6. eBook Collection (EBSCOhost)
7. Expanded Academic ASAP
8. Global Issues in Context
9. JSTOR Arts & Sciences
10. JSTOR eBooks (DDA & EBA started FY2020)
11. JSTOR Life Sciences (started FY 2020)
12. Kanopy
13. ProQuest Social Science Database
14. SciFinder (started FY 2020)
15. SocIndex with Full Text

Database usage data disaggregated by discipline does not exist and it is not possible to determine how many articles were accessed by Earth and Geographic Sciences faculty and students only. In total though for the Fitchburg State community, over 148,000 articles were accessed through the Library's 168 databases in fiscal year 2019.



	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Environmental Studies and Policy Collection				36	44	95	121
GeoRef	3761	4468	3278	1417	1359	2328	1764
ProQuest Science Database	1967	2445	1729		1145	1259	1011
Science & Technology Collection			1810	1518	1279	1458	1046
Science in Context	108	89	121	96	57	141	125

Library Table 2:

Monograph Collection Description and Analysis

Fitchburg State University is, by Carnegie classification, a Master's granting institution. The Earth and Geographic Sciences program offers B.S. and B.A. degrees, and therefore the University must currently uphold at least the standard of 3a, "Basic Study" for its collections, with the goal of offering the standard of 3b, "Intermediate Study" (see below).

General Guidelines for Monograph Collection Depth

1	Minimal – A level that consists mostly of basic works.
2	Basic Information.
2a	A level that introduces and defines the subject and that indicates the varieties of information available elsewhere.
2b	Basic Instructional Support – A level that introduces course work and research for undergraduate courses, including a wide range of basic monographs and reference tools pertaining to the subject and targeted to undergraduate students.
3	Study or Instructional Support.
3a	Basic Study – A level that supports undergraduate courses.
3b	Intermediate Study – A level that supports upper division undergraduate courses.
3c	Advanced instructional Support – A level that supports course work and research for graduate and undergraduate courses, including a wide range of basic monographs and reference tools pertaining to the subject.
4	Research – A level that supports independent research and preparation of doctoral dissertations
5	Comprehensive Inclusion – Comprised of all significant works for a defined topic.

*Specific Definitions for Monograph Holdings**

1b	(or less) Minimal level = less than 2,500.
2a	Basic introductory level = 2,500 - 5,000 titles.
2b	Basic advanced level (Community College) = 5,000 - 8,000 titles.
3a	Instructional support (lower level undergraduate) = 8,000-12,000 titles representing a range of monographs.
3b	Intermediate support level (advanced undergraduate) = more than 12,000 titles representing a wider range than 3a.
3c	Advanced support level (Master's degree level) = more than 12,000 titles representing a wider range than 3c.

*Quantitative WLN Criteria for Determining CL (Current Collection Level) Rating

Earth and Geographic Sciences Book Collection

LC Subject Area Earth and Geographic Sciences	LC	2019
Geography	G	737
Mathematical geography	GA	88
Physical geography	GB	281
Oceanography	GC	224
Environmental sciences	GE	418
Human ecology	GF	369
Population in geography	HB 1951-HB 3697	84
Economic geography	HF 1021-HF 1027	10
Political geography	JC 319-JC 322	24
Science study and teaching	Q 181-Q 222	58
Astronomy	QB	455
Physics	QC	1,112
Geology	QE	448
Ecology	QH 414-QH 535	408
Environmental technology	TD	303
Mining	TN	35
Total		**5,054**

The total number of print books in the call number ranges associated with Earth and Geographic Sciences is 5,054. This is lower than the number expected for a collection to support lower level undergraduate (8,000-12,000 books). Effective March 2019, the EBSCO Academic Complete eBook package was subscribed to that included approximately 7,852 Earth and Geographic Sciences related eBooks to meet the needs of the undergraduate researcher and the faculty**;** 1,096 of these eBooks were published in the last 5 years and 3,784 were published in the past 10 years. In addition to this, we also added the JSTOR EBA and DDA eBook collections which included 1,459 Earth and Geographic Sciences related eBooks; 527 of these were published within the last 5 years and 908 were published within the last 10 years. This increases the number of books associated with Earth and Geographic Sciences in total to **14,365** books while providing off-campus access. This total number brings the collection well above the level for lower level undergraduates (8,000-12,000 books) to the intermediate support level (12,000+ books).

Library Table 3:

Film and Other Media Collection

# of Streaming Films by Subject in Kanopy Database	
Agriculture & Geology	319
Animals	560
Applied Science	619
Biology	222
Chemistry	218
Environmental Sciences	1100
Science, Nature, & Technology	699
Zoology	248
Total (may include duplicates)	**3,985**

Library Table 4:

Library Instruction

	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Total Instruction Sessions Conducted:	211	197	161	222	263	247	266
Earth and Geographic Sciences Sessions Conducted:	1	1	2	0	1	0	0
Percentage	0.47%	0.51%	1.24%	0.00%	0.38%	0.00%	0.00%
Total Embedded:	13	16	18	42	99	63	72
No. of Earth and Geographic Sciences Embedded:	0	0	0	0	0	0	0
Total In-person:	198	181	143	180	164	184	194
No. of Earth and Geographic Sciences In-person:	1	1	2	0	2	1	1

** The library offers discipline-specific and general information literacy instruction sessions.*

**Note: These discipline statistics are based on GEOG courses listed under the Environmental and Earth Science Program Overview on the university website: https://www.fitchburgstate.edu/academics/undergraduate/undergraduate-day-programs/earth-systems-science/*

Library Table 5:

Research Help

Library Research Guides

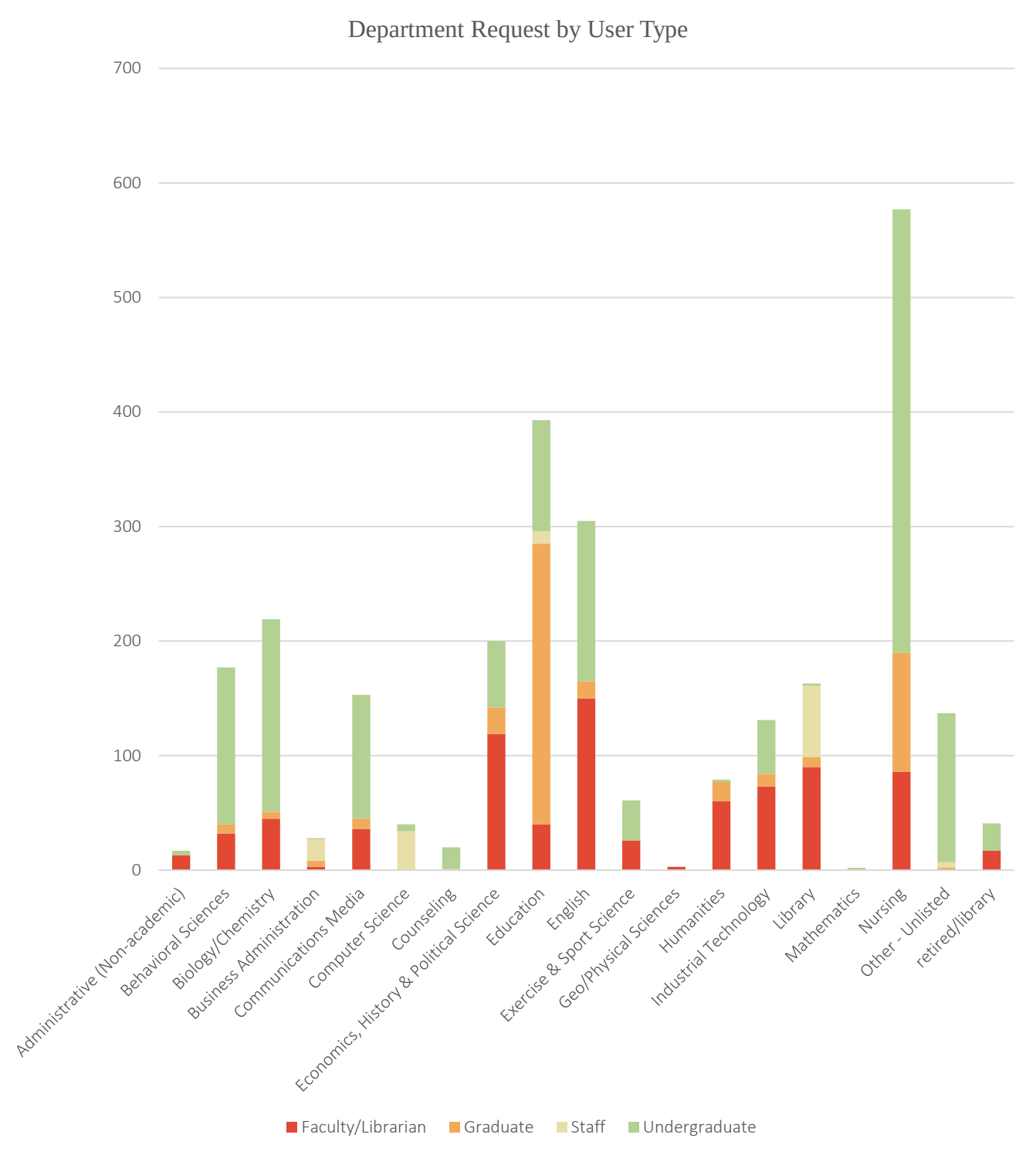
The library has created one subject research guide and two course specific research guides for Earth and Geographic Sciences. The usage statistics in the Geo/Physical Sciences research guide show the guide was accessed 103 times. Effective in Fall 2019, the Earth and Geographic Sciences research guide was embedded in all Earth and Geographic Sciences Blackboard courses; guide usage since the beginning of AY19-20 has already surpassed the totality of AY18-19.

Reference Statistics for University

	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Total Records	**4377**	**3544**	**2642**	**2497**	**1875**	**2854**	**2803**
Mode of Access	**FY2013**	**FY2014**	**FY2015**	**FY2016**	**FY2017**	**FY2018**	**FY2019**
In Person	3383	2490	1959	1872	1386	2297	2253
Chat	779	678	548	510	308	268	229
Phone/Email	133	272	133	112	162	287	320
Skype	0	12	0	0	0	1	1
Office/Appointment	82	47	2	3	19	0	15
Blackboard	0	27	0	0	0	10	0
Questions by Patron	**FY2013**	**FY2014**	**FY2015**	**FY2016**	**FY2017**	**FY2018**	**FY2019**
Student	3426	3016	2438	2320	1674	2632	2538
Faculty	104	102	59	66	57	65	116
Extended Campus/DL	15	256	27	21	45	112	180
Public/Alumni/Other	165	145	111	79	89	131	123
Staff	29	16	7	11	10	8	14
Unknown	638	13	0	0	0	0	0
Duration	**FY2013**	**FY2014**	**FY2015**	**FY2016**	**FY2017**	**FY2018**	**FY2019**
0-2 minutes	1510	1449	1104	1006	782	1483	1418
2-5 minutes	1215	1008	735	683	532	689	634
5-15 minutes	1079	628	509	424	327	331	350
15 minutes or longer	466	466	294	384	234	351	401
Blank	107	1	0	0	0	0	0

Library Table 6:

Interlibrary Services



Library Table 7:

Facilities

Space	Specifications
Total Number of Seats in Library	596
Information Commons	Research Help Desk Circulation Desk 61 public computer stations 3 multi-function printers.
Study Rooms	9 large (up to 8 people) containing conference table, white board, media viewing equipment, and Apple TV. 8 small (2 people) containing conference table, computer, and whiteboard.
Media Production Room	Seating up to 7 people containing a computer, Apple TV, ceiling mounted projector, DVD player, and document projector.
Quiet Space	2 floors (3rd and 4th)
Archives	34,889 items used in FY19 38 Special Collections totaling 322 boxes. 13 record groups totaling 480 boxes 2,500 rare books Art collection

Study Room Statistics	FY19
Unique Users	1743
Total Bookings	9454
Hours Booked	16869