Michigan Tech

Office Memo

Office of the Provost and
Senior Vice President for Academic Affairs

Phone: (906) 487-2440
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TO: Richard Koubek, President

FROM: Jacqueline E. Huntoon, Provost & Senior Vice President for Academic Affairs

Jacqueline E Huntoon

DATE: April 22, 2021

SUBJECT: Senate Proposal 59-21

Attached is Senate proposal 59-21, “Proposal for a Bachelor’s of Science Degree in Environmental Science and Sustainability,” and a memo stating the Senate passed this proposal at their April 21, 2021 meeting. I have reviewed this memo and recommend approving this proposal.

I concur X do not concur _____ with this recommendation.

Richard Koubek, President

4/26/21

Date

Michigan Tech

University Senate

DATE:	April 22, 2021
TO:	Richard Koubek, President
FROM:	Samuel Sweitz University Senate President
SUBJECT:	Proposal 59-21
COPIES:	Jacqueline E. Huntoon, Provost & Senior VP for Academic Affairs

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At its meeting on April 21, 2021, the University Senate approved Proposal 59-21, "Proposal for a Bachelor's of Science Degree in Environmental Science and Sustainability". Feel free to contact me if you have any questions.

The University Senate of Michigan Technological University

Proposal 59-21

(Voting Units: Academic)

Proposal for a Bachelor's of Science Degree in Environmental Science and Sustainability.

Proposed by: College of Forest Resources and Environmental Science

1. Date: March 30, 2021

2. Contacts: Jared D. Wolfe (Assistant Professor), Tara L. Bal (Assistant Professor), Andrew J. Storer (Dean)

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4. General Description of the Program

A. Mission - To provide students with a broad understanding of environmental science and sustainability to prepare them for careers in this field. Students will develop a strong basis in the biophysical sciences, while also being prepared to address the challenges of integrating societal needs and perspectives into working towards a sustainable future for the environment. The programs will be distinctive in its science-based curriculum that integrates contemporary issues in social justice, diversity, equity and inclusion.

B. Programmatic goals - The goal of this degree program is to give students a strong technical foundation in understanding of the natural environment, the forces that shape and are shaped by it, and the contemporary environmental challenges faced by society. This technical background will include a strong grounding in the biophysical sciences as well as courses that focus on specific environmental topics and challenges. Students will then build upon this technical foundation through one of three tracks with which to further develop their knowledge base: 1) Climate Science, 2) Environmental Policy, and 3) Geospatial Science. These tracks have been planned such that students gain an interdisciplinary perspective on climate science and climate change, policies that relate to human-environment interactions, or geospatial applications to environmental science and sustainability.

1) Track in Climate Science
Students electing the Climate Science track will complete classes relating to topics such as the science of climate change, wildland fire, and environmental biogeochemistry. In addition, they will take a class in team dynamics and decision making as graduates from this track will need these types of skills to be effective in the work place.

2) Track in Environmental Policy
Students electing the Environmental Policy track will complete classes that provide in-depth topics that relate closely to policy, including conservation biology and wetlands, as well as classes in the social sciences that broaden their perspective in the linkages between the environment and needs of humans.

3) Track in Geospatial Science
Students electing the track in Geospatial Science will take courses that add to their skillsets in collecting geospatial data, visualizing this data and large-scale consideration of landscapes. Students in this track will also take an extra semester of physics which includes gaining important understanding of the physics of light which is relevant to remote sensing technologies.

The free electives in the program also enable students to develop their own areas of focus beyond that provided in the track that they chose. Students may also choose to use the free electives to pursue other academic credentials such as a Minor in Business, a language minor, or a Minor in Diversity Studies. In the future, additional tracks may be offered within the framework of the degree program.

C. Learning Goals and Competencies

Learning goal	Description
Disciplinary knowledge	Explain core concepts in the field of environmental science and sustainability.
Evaluating information	Identify and evaluate sources of information relating to the environment and sustainability
Solutions to problems	Summarize and analyze alternative solutions to situations or problems associated with issues in environmental science and sustainability
Human dimensions	Assess the diverse human relationships, perceptions, and policies related to the environment.
Communication	Communicate effectively (orally and in writing) about issues related to environmental science and sustainability
Professionalism	Recognize the professional standards that ensure their behaviors are consistent with working in the environmental science field
Teamwork	Perform effectively in teams

Track specific learning goals:
1) Climate Science – Students will explain atmospheric processes, describe defining features of climates, and discuss the major factors that influence climate change
2) Environmental Policy – Students will evaluate and apply environmental policy to environmental and sustainability issues.
3) Geospatial Science – Students will integrate the use of geospatial tools to address issues relating to the natural environment.

D. Administration – The Environmental Science and Sustainability program will be administered through the College of Forest Resources and Environmental Science (CFRES). The CFRES academic advisor will assist students with scheduling and degree completion. Advice on directed electives and career choices will be provided by CFRES faculty and the academic advisor.

5. Title of Program: BS Environmental Science and Sustainability

6. Rationale

This program is a major part of a plan to increase enrollments and undergraduate education in the College of Forest Resources and Environmental Science. The College is home to a top 5 nationally ranked forestry program and also offers other natural resource management degrees, including Wildlife Ecology and Conservation, Applied Ecology and Environmental Science, and Natural Resources Management. As such, it is highly visible at a national level, and this will be helpful as we seek to build a nationally recognized program in environmental science and sustainability. The transition of the College from a School at Michigan Tech was designed as a mechanism for growth through the expansion of the breadth of degree program offerings. This has included the new BS in Sustainable Bioproducts (first offered in Fall 2020) along with this proposed BS in Environmental Science and Sustainability.

Sustainability of natural resources is at the core of the programs offered in the College of Forest Resources and Environmental Science, and notions of sustainable harvesting from the 18th century were an important step in the process of managing natural resources for multiple uses. Concepts of sustainability have evolved as societies have worked to understand what they want to sustain and to

learn how to do this. These concepts are important parts of the University strategic goal of working towards a just and sustainable world. Students in this major will work with students in other majors in the College both in the classroom and through our range of student organizations. This will broaden their perspectives and contribute to their distinctiveness as graduates of our programs.

According to the Integrated Postsecondary Education Data System (IPEDS), the largest portion of natural resource majors are programs that classify as Environment Science and Studies (53% in 2018) compared with 4% in forestry, and 9% in fisheries and wildlife. The balance is largely in recreation programs and natural resource conservation and management programs. Considering programs that are members of the National Association of University Forest Resource Programs (NAUFRP), 2017 enrollments were 14% in forestry programs, 27% in fisheries and wildlife programs, 22% in Natural Resource Conservation and Management programs, and 24% in Environmental Science and Studies programs. The change in enrollments in these programs between 2013 and 2018 show increases in Environmental Science and Studies programs (3.8% increase to 13,611 students), and Fisheries and Wildlife programs (3.6% increase to 2,436 students). Natural Resources Conservation and Management showed an increase of only 1.5% to 2,950 students, and Forestry a 0.4% increase to 1039 students. (Data from Food and Agricultural Education Information Systems summarized in https://faeis.cals.vt.edu/wp-content/uploads/2020/01/SAF-2019-Presentation-on-NR-Enrollment-Trends.pdf).
Environmental Science and Studies programs have enrollments nationally that are 57.6% women. Fisheries and wildlife have enrollments that are around 50% women, and representation of women in forestry enrollments are increasingly, but still only at 23.0% of students. The Bureau of Labor Statistics indicate that growth in environmental science and specialist positions will be much faster than average with the addition of 5,000-10,000 new jobs in the next five years (https://www.bls.gov/ooh/life-physical-and-social-science/environmental-scientists-and-specialists.htm).

This major supports and draws upon the themes of a number of the Tech Forward Initiatives, including those in Diversity and Inclusion; Sustainability and Resilience; Natural Resources, Water and Energy; Policy, Ethics and Culture; and Human Health and Quality of Life. Students in this program will develop knowledge critical to the resilience of our shared environment, and engage in timely dialogue on matters of Justice, Equity, Diversity and Inclusion (JEDI). The goals are to increase our understanding of the diverse perspectives and practices in our region, and to continue to build and strengthen sustainable partnerships among our schools and communities into the future. This program will explore Western and Indigenous science, and create space for students to explore broad perspectives, and work to ensure an inclusive and equitable educational experience.

7. Related Programs within the Institution and in the Region

At Michigan Tech

BS in Applied Ecology and Environmental Science. The Applied Ecology and Environmental Science program at Michigan Tech has been in place for over 20 years. Students are attracted to it as a blend of environmental science and ecological management of natural systems. As such is has a more management focused curriculum than the proposed program and appeals to students who are looking for a knowledge set in ecology and environmental science to prepare them as managers of natural ecosystems and for work in ecological restoration.

BS in Sustainability Science and Society. The BS in Sustainability Science and Society program is offered through the Department of Social Sciences This major explores the interactions between global, social, and natural systems in order to understand how sustainable those systems are. The goal is to meet

present needs (such as health, energy, food, shelter, and transportation), without compromising the ability of future generations to meet their own needs. In light of unprecedented environmental degradation, social instability, and economic uncertainties in today's world, the degree in sustainability cultivates the complex knowledge and skills needed for graduates to foster a secure and healthy future for all. Students in the Sustainability Science and Society major explore real world problems to understand the interaction of environmental, economic, and social systems. This program provides breadth with classes that include environmental policy, engineering sustainability, communities, environment and society, environmental health and justice, or environmental decision-making, and provide the opportunity to develop additional focus in one of these areas.

BS in Environmental Engineering. The BS in Environmental Engineering is an ABET accredited engineering program that attracts a different group of students than the proposed program. The focus for environmental engineering is applying engineering principles to the design of technologies to solve environmental issues in natural and manmade systems.

Other universities

Degree programs in Environmental Science and Environmental Studies are fundamental to the degree offerings of most universities. Each university brings different areas of expertise their programs, and this helps each of them be distinctive when students are working to decide where to study. The anticipated increase in demand for environmental scientists in the workforce suggests that all of these programs will have a niche in this broad field. Many other universities in Michigan offer degree programs in Environmental Science or Environmental Studies. Increasingly, these are reemerging to include sustainability due to the increase prevalence of this as a concept and need for the future. Michigan Tech is notable in that it does not have an Environmental Science or Studies degree program. Programs titled as Environmental Sciences generally have a core of biophysical science classes, whereas those titled as Environmental Studies have less of this science content. The proposed major combining Environmental Science and Sustainability will be the first of these in Michigan.

University	Examples of undergraduate bachelor's programs (non-engineering)
Northern Michigan University	Environmental Science Environmental Studies and Sustainability
Michigan State University	Environmental Studies and Sustainability Environmental Geosciences Environmental Economics and Management Environmental Biology (various options)
Western Michigan University	Environmental and Sustainability Studies
Eastern Michigan University	Environmental Science and Society
Lake Superior State University	Environmental Science
Ferris State University	Concentration within other degree programs
University of Michigan – Ann Arbor	Environment Earth and Environmental Sciences
University of Michigan – Dearborn	Environmental Studies Environmental Science
Grand Valley State University	Environmental and Sustainability Studies
Oakland University	Environmental Science
Wayne State University	Environmental Science

Other programs in region

As would be expected, many other universities in the region also offer degree in the environmental science field. This includes degrees at University of Wisconsin, Madison (Environmental Sciences; Environmental Studies), University of Minnesota (Environmental Geosciences; Environmental Sciences, Policy and Management), and University of Minnesota, Duluth (Environmental Science).

8. Projected Enrollment

Over the first years of this major, we anticipate a steady state enrollment of approximately 100 students with 20-30 students enrolling in the program each year. This level of enrollment will require the addition of a single lab section for classes that include a lab with 20-24 student enrolling in each year. The students attracted to this new major will include those who would not otherwise attend Michigan Tech as they are not looking for an engineering program, or a program focused on land or ecological management. Rather they will be students interested in entering the workforce in the field of environmental science with a focus on addressing environmental challenges and the sustainability of the environment.

9. Curriculum Design

Students will be required to take 39 general education credits which includes 15 of the 22 credits of mathematics (calculus and statistics) and science (chemistry, physics, and biology) that are required preparation to the Environmental Science and Sustainability core courses (45 credits). Each Track contains 13-15 credits. Students will have 14-16 credits of free electives to reach the minimum credit requirement of 120 credits. In addition, students will complete 3 units of co-curricular (PE) courses.

I. General Education (24 Credits + 15 Credits from the base math and science list)

UN 1015 Composition (3)
UN 1025 Global Literacy (3)
Goal 4 Critical Thinking (3)
Goal 8 Social Responsibility (3)
HASS Electives (12)

II. Base Math and Science (22 Credits)

BL 1100 General Biology I: Introduction to Organismal Biology, Ecology, and Evolution	3
BL 1200 General Biology II: Introduction to Cellular and Molecular Biology	3
CH 1150 University Chemistry I	3
CH 1151 University Chemistry Lab I	1
MA 1135 Calculus for life sciences	4
MA 2720 Statistical Methods	4
PH 1110 College Physics I	3
PH 1111 College Physics I Laboratory	1

III. Environmental Science and Sustainability core courses (45 Credits)

FW 1050 The Natural Resources Professional	2
FW 2051 Field Techniques	2
FW 2060 Fundamentals of Environmental Sustainability	3
FW 3760 Human Dimensions of Natural Resources	3
FW 3020 Forest Ecology	3
FW 3110 Natural Resource Policy	3
FW 3313 Sustainability Science	3

FW 3330 Soil Science	4
FW 3540 Introduction to GIS for Natural Resources	4
FW 4081 Circular Economy	3
FW 4111 Indigenous Natural Resource Management	3
BL 3310 Environmental Microbiology	3
SS 2300 Environment and Society	3
FW 4710 Environmental Biogeochemistry	3
FW 4XXX Environmental Science and Sustainability (ESS) Capstone	3

IV. Choose 1 of 3 Tracks: 1) Climate Science, 2) Environmental Policy, and 3) Geospatial Science (15 credits each).

IV.1. Climate Science (15 Credits)

FW 4300 Wildland Fire	3
FW 4370 Forest and Landscape Hydrology	3
FW 4421/5421 Climate Change and Management in Great Lakes Forest Ecosystems	3
MGT 2000 Team Dynamics and Decision Making	3
Choose 1 of the following 2 classes	
GE 2640 Atmospheric Observation and Meteorology	3
FW5419 Atmospheric Biogeochemistry	3

IV.2. Environmental Policy (13-14 credits)

FW 3410 Conservation Biology	3
FW 4180 Ethics of Conservation and Sustainability	2
FW 4220 Wetlands	3
Choose 2 of the following classes (5-6 credits)	
SS 3110 Food Systems & Sustainability	3
SS 3315 Population, Health and Environment	3
SS 3520 U.S. Environmental History	3
SS 3630 Environmental Policy and Politics	3
SS 3750 Social Inequality	3
SS 3801 Science, Technology & Society	3
SS 3805 Environmental Justice	3
SS 3815 Energy & Society	3
SS 4400 Environmental Sociology	3
FW 4070 Ge-izhi-mawanji'idiyang dazhindamang gidakiiminaan- the way we meet to talk about our earth	2

IV.3. Geospatial Science (15 Credits)

PH 1200 Physics by Inquiry II	1
PH 1210 College Physics II	3
FW 4380 Landscape Ecology and Planning	3
FW 4540 Remote Sensing of the Environment	3
FW 4542/5541 Remote Sensing of the Environment Lab	1
FW 4545 Map Design with GIS	2
FW 4554/5554 GPS Field Techniques	2

V. Free electives (14-16 credits)

10. New Course Descriptions

There are some 4000 level courses that will be included in the white book as dual listings with existing graduate level courses. The numbers for these graduate level courses are shown in the above table. In each case the graduate courses that they will be dual listed with have the same prefix, and are introductory graduate courses. The course learning goals will be modified in the syllabi for the undergraduate versions of the courses.

The classes that will have an upper division undergraduate course added are:

- FW 5554 GPS Field Techniques (2 credits). Will submit to be listed as FW4554 in Fall 2021.
- FW 5541 Remote sensing of the environment lab (1 credit). Will submit to be listed as FW 4542in Fall 2021.
- FW 5421 Climate Change and Management in Great Lakes Forest Ecosystems (3 credits). Will submit to be listed as FW4421 in Fall 2021.

FW 4XXX Environmental Science and Sustainability (ESS) Capstone (3 credits). This course is a capstone experience in which students will identify, research and report on a current issue in environmental science and sustainability. They will draw on the knowledge and experiences in previous courses in the major to synthesize broad perspectives on contemporary issues, and communicate this work in writing and as an oral presentation. The course proposal is attached.

11. Model Schedules

BS in Environmental Science and Sustainability. Track: Climate Science (total 120 credits)

	Course 1	Cr.	Course 2	Cr.	Course 3	Cr.	Course 4	Cr.	Course 5	Cr.	Total
Fall 1	UN1015	3	MA 1135 Calculus for life sciences	4	BL 1100 General Biology I	3	PH 1110/PH111 College Physics I & lab	4	FW 2051 Field Techniques	2	16
Spring 1	UN1025	3	HASS	3	BL 1200 General Biology II	3	MA 2720 Statistical Methods	4	FW 1050 The Natural Resources Professional	2	15
Fall 2	Crit Creat Think	3	CH 1150/1151 University Chemistry I with lab	4	FW 2060 Fundamentals of Environmental Sustainability	3	FW 3020 Forest Ecology	3	FW 3760 Human Dimensions of Natural Resources	3	16
Spring 2	Soc Res Ethic	3	HASS	3	BL 3310 Environmental Microbiology	3	FW3540 Introduction to GIS for Natural Resources	4	FW 3110 Natural Resource Policy	3	16
Fall 3	HASS	3	FW 3330 Soil Science	4	SS 3520 U.S. Environmental History	3	FW 3313 Sustainability Science	3	Free Elective	3	16
Spring 3	HASS	3	FW 4111 Indigenous Natural Resource Management	3	FW 4081 Circular Economy	3	FW 4710 Environmental Biogeochemistry	3	Free Elective	3	15
Fall 4	FW 4421/5421 Climate Change and Management	3	MGT 2000 Team Dynamics and Decision Making	3	Free Elective	3	Free Elective	3			12
Spring 4	FW 4300 Wildland Fire	3	FW 4370 Forest and Landscape Hydrology	3	FW 5419 Atmospheric Biogeochemistry	3	FW 4XXX ESS Capstone	3	Free Elective	2	14

Key:	
	Science and Math
	Core
	Track
	Gen Ed
	Free elective

Degree schedules require a minimum of 3 units of Co-curricular/PE units. In this model schedule, 0.5 units would be completed in each of the first six semesters.

BS in Environmental Science and Sustainability. Track: Environmental Policy (total 120 credits)

	Course 1	Cr.	Course 2	Cr.	Course 3	Cr.	Course 4	Cr.	Course 5	Cr.	Total
Fall 1	UN1015	3	MA 1135 Calculus for life sciences	4	BL 1100 General Biology I	3	PH 1110/PH111 College Physics I & lab	4	FW 2051 Field Techniques	2	16
Spring 1	UN1025	3	HASS	3	BL 1200 General Biology II	3	MA 2720 Statistical Methods	4	FW 1050 The Natural Resources Professional	2	15
Fall 2	Crit Creat Think	3	CH 1150/1151 University Chemistry I with lab	4	FW 2060 Fundamentals of Environmental Sustainability	3	FW 3020 Forest Ecology	3	FW 3760 Human Dimensions of Natural Resources	3	16
Spring 2	Soc Res Ethic	3	HASS	3	BL 3310 Environmental Microbiology	3	FW3540 Introduction to GIS for Natural Resources	4	FW 3110 Natural Resource Policy	3	16
Fall 3	HASS	3	FW 4180 Ethics of Conservation and Sustainability	2	FW 3330 Soil Science	4	FW 3313 Sustainability Science	3	Free Elective	3	15
Spring 3	HASS	3	FW 3410 Conservation Biology	3	SS 2300 Environment and Society	3	FW 4710 Environmental Biogeochemistry	3	Free Elective	3	15
Fall 4	FW 4220 Wetlands	3	SS 3520 U.S. Environmental History	3	Free Elective	3	Free Elective	3			12
Spring 4	SS 3110 Food Systems & Sustainability	3	FW 4111 Indigenous Natural Resource Management	3	FW 4081 Circular Economy	3	FW 4XXX ESS Capstone	3	Free Elective	3	15

Key:

Science and Math
Core
Track
Gen Ed
Free elective

Degree schedules require a minimum of 3 units of Co-curricular/PE units. In this model schedule, 0.5 units would be completed in each of the first six semesters.

BS in Environmental Science and Sustainability. Track: Geospatial Science (total 120 credits)

	Course 1	Cr.	Course 2	Cr.	Course 3	Cr.	Course 4	Cr.	Course 5	Cr.	Total
Fall 1	UN1015	3	MA 1135 Calculus for life sciences	4	BL 1100 General Biology I	3	PH 1110/PH111 College Physics I & lab	4	FW 2051 Field Techniques	2	16
Spring 1	UN1025	3	HASS	3	BL 1200 General Biology II	3	MA 2720 Statistical Methods	4	FW 1050 The Natural Resources Professional	2	15
Fall 2	Crit Creat Think	3	CH 1150/1151 University Chemistry I with lab	4	FW 2060 Fundamentals of Environmental Sustainability	3	FW 3020 Forest Ecology	3	FW 3760 Human Dimensions of Natural Resources	3	16
Spring 2	Soc Res Ethic	3	HASS	3	PH 1200/1210 Physics by Inquiry II & lab	4	FW 4081 Circular Economy	3	FW 3110 Natural Resource Policy	3	16
Fall 3	HASS	3	FW 3330 Soil Science	4	SS 3520 U.S. Environmental History	3	FW 3313 Sustainability Science	3	Free Elective	3	16
Spring 3	HASS	3	FW 4111 Indigenous Natural Resource Management	3	FW3540 Introduction to GIS for Natural Resources	4	FW 4710 Environmental Biogeochemistry	3	Free Elective	2	15
Fall 4	FW 4540 Remote Sensing of the Environment & lab Fw4542	4	Free Elective	3	Free Elective	3	Free Elective	3			13
Spring 4	FW 4554/5554 GPS Field Techniques	2	FW 4545 Map Design with GIS	2	BL 3310 Environmental Microbiology	3	FW 4380 Landscape Ecology and Planning	3	FW 4XXX ESS Capstone	3	13

Key:

Science and Math
Core
Track
Gen Ed
Free elective

Degree schedules require a minimum of 3 units of Co-curricular/PE units. In this model schedule, 0.5 units would be completed in each of the first six semesters.

12. Library and Learning Resources

No additional materials required or requested.

13. Available/Needed Equipment (including Learning Resources and Space)

Program students will have access to the existing classroom, lab, and study spaces in CFRES. There is sufficient space available. No new space will be required by the program.

14. Program Costs and Justification for Years 1, 2, and 3

We expect that the only initial costs for the program will be advertising (including adjustments to MTU and CFRES websites, and recruiting). The expected costs are estimated to be $1,000- $2,000 per year. We are not requesting additional resources at this time.

Additional Courses: The remaining courses that are new at the undergraduate level are already offered at the graduate level. There is capacity in these classes for junior and senior undergraduates to take the new undergraduate version of these classes. The new capstone course will be taught by existing instructional personnel.

As the program grows, additional sections of some of the core and track classes may be needed, and this may include the need for additional TA support for some classes.

15. Accreditation requirements

There are no accreditation requirements for the Program beyond those required by the Higher Learning Commission.

16. Planned Implementation Date

We anticipate a Program starting date of Fall 2021. In addition, we will spend the next academic year working with University Marketing and Communication on efforts relating to advertising and outreach, and most of the benefits of these efforts will be seen in increased enrollment in the Fall 2022 semester.

Sections for New Degree Programs

1. Program Administration, Policies, Regulations, and Rules

Administration of the Program will reside with the Dean of the College of Forest Resources and Environmental Science, who reports to the Executive Vice-President and Provost for Academic Affairs. Policies, regulations, and rules are those of the University.

2. Scheduling Plans (Extension, Evening, Regular)

At the outset, the scheduling of this degree will be regular on campus classes. However, some of the classes are expected to become available through remote learning, increasing the flexibility for students enrolled in the program.

3. Space

Program students will have access to the existing classroom, lab, and study spaces in CFRES. There is sufficient space available. No new space will be required by the program.

4. Faculty resumes
Faculty resumes are downloadable from the faculty webpages that are linked from https://www.mtu.edu/forest/about/faculty-staff/.

5. Financial Documentation
See appendix A.

Approvals:

CFRES: Approved by CFRES faculty, February 19, 2021.

Deans Council: March 3, 2021.

University Senate

Michigan Tech Administrative Approval

Appendix A - Financial Documentation

I. Relation to University Strategic Plan
A. Relation of program to the University's educational and research goals.
The proposed Program conforms to the University Strategic Plan and includes a rigorous, interdisciplinary curriculum of classroom, laboratory, and experiential learning that will enhance student preparedness for the future job market or further education. Hence the major fits the University's educational goal to "Provide a distinctive and rigorous action-based learning experience grounded in science, engineering, technology, sustainability, business, and an understanding of the social and cultural contexts of our contemporary world."

B. Consistency with the University's resource allocation criteria.
We are not requesting any allocation in salary or space for this degree.

II. Impact on University Enrollment
A. Projected number of students in the program.
We project a class size of 20-25 students with an eventual Program size of 100 students.

B. Source of new students; in particular, will the students be drawn from existing programs, or will they be students who would otherwise not have come to Michigan Tech?
We expect that most of the students in this major will not otherwise have come to Michigan Tech. Students looking for a science-based degree to learn about environmental science and sustainability will be attracted to this program. We will advertise the program with a focus on high schools with AP Environmental Science classes. There may be some students who move in the program from existing forestry and engineering programs at the University. This should help to improve overall retention at the University as these students may have left the MTU in search of alternatives.

C. What is the likely correlation between demand for the new program and existing enrollment patterns at Michigan Tech?
We anticipate the proposed program will increase the enrollment in CFRES, and this is consistent with the goal of the program and of the College. We do not anticipate that enrollments in other academic units will be impacted, though some students who may not be retained in other programs may transfer internally to this program rather than leave the University. This will improve the effective retention rates.

What is the current enrollment in the unit?
2020-2021: 197 undergraduate students, 64 graduate students
2019-2020: 183 undergraduate students, 68 graduate students
2018-2019: 168 undergraduate students, 71 graduate students
Source: Compendium

III. Impact on Resources Required by Department in which the Program is Housed. (including but not limited to):
A. Faculty lines.
None.

B. Faculty and student laboratories, including ongoing maintenance.
The existing labs are sufficient to deliver the lab-based core and track classes.

C. Advising.
The CFRES academic advisor will assist students with scheduling and degree completion. Additional advice on free electives and career choices will be provided by CFRES faculty.

D. Assessment.
The proposed Program will be assessed as part of the University's assessment activities. All of the University learning goals and those learning goals related to disciplinary knowledge will be addressed by the Program curriculum.

IV. Impact on Resources Required by other Units Within the University. Including but not necessarily limited to impacts on:

A. Other academic (e.g., General Education) units with regard to faculty, laboratories, and assessment. (Note: The current student to faculty ratio for the university as a whole is approximately 12:1 per Institutional Analysis.)
The respective units have reviewed their courses and none have indicated insufficient capacity for students of this proposed Program. We recognize that as the program grows there may be the need to add sections to come classes, and this may include the need for additional TA support. This is the same as for any new program that aims to increase enrollments.

B. Informational Technology, the Library, central administration and career planning with respect to the impact on the need for computing services, library resources, advising, record keeping, development of employer relations, etc.
Existing resources are sufficient to support the anticipated enrollment.

V. Assessment of the Ability to Obtain the Necessary Resources Assuming Requested Funds are Obtained. For high demand fields (e.g., business fields, etc.), will it be possible to fill allocated lines.
No faculty lines are needed to establish this degree.

VI. Past Proposals. Has the unit initiated any other degree programs in the last five years?
An undergraduate degree program in Natural Resources Management (NRM) was created in 2016.
An undergraduate degree program in Sustainable Bioproducts started in Fall 2020.

A. Describe the extent to which the new programs have met the original goals with respect to:
1. Enrollment.
Enrollment in the NRM program has been low and the program is under review to explore ways to enhance enrollments. The Program is fairly new and requires more marketing to increase enrollment. The program is also considering some restructuring to increase its attractiveness.
While it is too early to evaluate enrollments in the Sustainable Bioproducts program, it is being promoted to students interested in the intersection between the environment, engineering and business. The associated Enterprise team (HOTFOREST) has attracted students from multiple academic programs, including students transferring into the Sustainable Bioproducts program. This program is part of the College plan to increase enrollments in undergraduate degree programs though the continued broadening of degree program areas.

2. Costs.
The recent programs have met the goals related to costs.

3. New faculty
No new faculty lines were required to initiate the new programs.

4. Other resources required for the program
None.

B. How have degree programs added in the past five years affected total enrollment in the unit?
Enrollments in the unit has increased by 17.5% over the past two years. The effect of new programs on this is difficult to evaluate in the early stages as some enrollment increases may be a result of students discovering other programs in the unit while investigating new programs.

VII. Departmental Budget Contribution
A. What is the department's total general fund budget?
CFRES General Fund Base Budget 2019-2020 $4,394,402 (source: Compendium).
CFRES General Fund instructional expenditures 2019-2020 $2,673,466 (source: Compendium)

B. How much tuition does the unit generate? This information should be provided for both the credit hours taught by the unit and the number of credit hours taken by the unit's majors.
In FY 2019-2020, CFRES generated $3,836,464 in tuition for credit hours taught by CFRES, and $3,256,480 in tuition by the number of credit hours taken by CFRES enrolled undergraduate students calculated from flat tuition rate published for 83 lower division and 100 upper division students.

VIII. How do the benefits from this program compare to other alternatives that are currently under consideration or development. Will approval and allocation of resources to this program preclude the development of other programs?
This program is a logical addition to the programs offered through CFRES. Other programs that are being considered or in development include graduate certificates and programs, and an undergraduate program that addresses the emerging need for training in data science and natural resources. The approval of the BS in Environmental Science and Sustainability does not preclude the development of these programs.

Appendix B – Sample Degree Audit

Academic Year 2020-2021
Bachelor of Science in Sustainable Bioproducts
College of Forest Resources and Environmental Science

Estimated Graduation Date

Course Number	Credits		Course Number	Credits
BL 1100 General Biology I	3			
BL 1200 General Biology I	3			
CH 1150 University Chemistry I	3			
CH 1151 University Chemistry Lab I	1			
MA 1135 Calculus for life sciences	4			
PH 1110 College Physics I	3			
PH 1111 College Physics I Laboratory	1			
MA 2720 Statistical Methods	4	MA 1032 or MA 1031 or ALEKS Math Placement		
FW 1050 The Natural Resources Professional	2			
FW 4710 Environmetal Biogeochemistry	3			
FW 2051 Field Techniques	2			
FW 2060 Fundamentals of Environmental Sustainability	3			
FW 3760 Human Dimensions ofNatural Resources	3			
FW 3020 Forest Ecology	3			
FW 3110 Nartural Resource Policy	3		**Credit Subtotal**	**0**
FW/SS 3313 Sustainability Science	3			
FW 3330 Soil Science	4			
FW 3540 Introduction to GIS for Natural Resources	4			
FW 4180 Circular Economy	3			
FW 4111 Indigenous Natural Resource Management	3			
FW 4XXX ESS Capstone	2			
BL 3310 Environmental Microbiology	3			
SS 2300 Environment and Society	3			
Credit Subtotal	**66**			

*__M__-Passed with valid grade, transfer, or Advance Placement credit; __R__egistered in course; __P__lan to take in future, __WVD__-Waived course or credit (does not reduce total degree

The options on page two represent 24 - 27 of the required credits for your degree. In consultation with your advisor you will choose one of three options:

Air and Climate Science: 15 credits
Environmental Policy: 14-15 credits
Geospatial Science: 15 credits

Course Number	Credits	Course Status Code M, R, P, WVD, SUB*
Option 1: Air and Climate Science		
Required Core Courses (12 credits)		
FW 4300 Wildland Fire	3	
FW 4370 Forest and Landscape Hydrology	3	
FW 4421 Climate Change and Management	3	
MGT 2000 Team Dynamics and Decision Making	3	
Electives (3 credits)		
GE 2640 Atmospheric Observation and Meteorology	3	
FW5419 Atmospheric Biogeochemistry	3	
Credit Subtotal	**15**	

Course Number	Credits	Course Status Code
Option 2: Environmental Policy		
Required Core Corses (9 credits)		
FW 3410 Conservation Bioloogy	3	
FW 4180 Ethics of Conservation and Sustainability	2	
FW 4220 Wetlands	3	
Electives (5-6 credits)		
SS 3110 Food Systems & Sustainability	3	
SS 3315 Population, Health and Environment	3	

Course Number	Credits	Course Status Code M, R, P, WVD, SUB*
Option 3: Geospatial Science		
Required Core Courses (15 credits)		
PH 1200 Physics by Inquiry II	1	
PH 1210 College Physics II	3	
FW 4380 Landscape Ecology and Planning	3	
FW 4540 Remote Sensing of the Environment	3	
FW 4545 Map Design with GIS	2	
FW 4542 Remote Sensing of the Environment lab	1	
FW 4554 GPS Field Techniques	2	
Electives		
Credit Subtotal	**15**	

SS 3520 U.S. Environmental History	3
SS 3630 Environmental Policy and Politics	3
SS 3750 Social Inequality	3
SS 3801 Science, Technology & Society	3
SS 3805 Environmental Justice	3
SS 3815 Energy & Society	3

gidakiiminaan- the way we meet to talk about our earth	2	
Credit Subtotal	**13-14**	

Credit Subtotal		
Air and Climate Science	81	
Environmental Policy	76-77	
Geospatial Science	81	

General Education Requirements: 24 Credits		
Course Number	Credi	Course Status Code
Courses used to complete General Education		

Core: 12 Credits		
UN 1015	3	
UN 1025 or upper level	3	
Critical and Creative	3	
Social Responsibility &	3	

HASS: 12 Credits		
Students must complete 12 credits of HASS course work		
Six of the 12 credits must be at the 3000- or 4000- level*		
At least three credits each in the following: Communication/Comp,		
Humanities and Fine Arts, and Social & Behavioral Sciences.		
No more than three credits may come from the Restricted List		
Communication/	minimum 3	
Humanities and Fine Arts	minimum 3	
Social and Behavioral	minimum 3	
Any List or Restricted List	0-3	

*an upper division language course in place of UN1025 does not meet this requirement.

Student Signature Date

Free Electives: 9 Credits		
Course Number	Cred	Course Status Code
Credit Subtotal	15	

Co-Curricular Activities: x Credits		
Required for graduation, but not included in the GPA calculation or in the overall credits required for the degree.		

Advisor Use Only	
Total Credits Required	120
Total Credits Completed	
Total Credits Needed	

Additional Information

(check all that apply)

Currently Enrolled in:

- ( ) Double Major _____
- ( ) Minor _____
- ( ) Second Degree _____

Departmental Approval Date

Appendix C: Complete List of Required Courses and Directed Electives

I: List of Required Math and Science Courses

BL 1100 General Biology I: Introduction to Organismal Biology, Ecology, and Evolution
A discussion of the principles of ecology and organismal biology, using the theme of physiological ecology and adaptations. This course will emphasize biodiversity, scientific method, experimental design, and written and oral presentation of results.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall, Summer

BL 1200 General Biology II: Introduction to Cellular and Molecular Biology
Discussion of the major principles by which life is organized. Topics include scientific methods, biological chemistry, cell structure and organization, multicellular organization, diversity of organisms, energetics and photosynthesis, cellular reproduction genetics, gene structure and expression, and recombinant DNA.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring, Summer

CH 1150 University Chemistry I
Introduces the foundations of chemistry, including electronic structure of atoms and molecules, intermolecular forces, states of matter, chemical reactions, organic chemistry, chemical equilibria, kinetics, and acid-base chemistry. Includes laboratory component that emphasizes lecture components.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall, Spring, Summer
Co-Requisite(s): CH 1151
Pre-Requisite(s): MA 1031(C) or MA 1032(C) or MA 1120(C) or MA 1160(C) or MA 1161(C) or MA 1135(C) or MA 1121(C) or ALEKS Math Placement >= 56 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2 or ACT Mathematics >= 22 or SAT MATH SECTION SCORE-M16 >= 540

CH 1151 University Chemistry Lab I
Laboratory to accompany CH1150.
Credits: 1.0
Lec-Rec-Lab: (0-0-3)
Semesters Offered: Fall, Spring, Summer
Co-Requisite(s): CH 1150
Pre-Requisite(s): MA 1031(C) or MA 1032(C) or MA 1120(C) or MA 1160(C) or MA 1161(C) or MA 1135(C) or MA 1121(C) or ALEKS Math Placement >= 56 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2 or ACT Mathematics >= 22 or SAT MATH SECTION SCORE-M16 >= 540

MA 1135 Calculus for Life Sciences
Topics include analytic geometry, limits, continuity of functions, transcendental functions, derivatives, integrals, and applications of the derivative in the fields of economics, biological sciences, and socials sciences. Extensive use of graphing calculator.
Credit applicable only to those curricula specifying this course.

Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: May not be enrolled in one of the following: College(s): College of Engineering
Pre-Requisite(s): MA 1032 or MA 1031 or MA 1120 or ALEKS Math Placement >= 76 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2 or ACT Mathematics >= 26 or SAT MATH SECTION SCORE-M16 >=610

MA 2720 Statistical Methods
Introduction to the design and analysis of statistical studies. Topics include methods of data collection, descriptive and graphical methods, probability, statistical inference on means, regression and correlation, and ANOVA. Not open to students with credit in MA2710, MA3710, or MA3715.
Credits: 4.0
Lec-Rec-Lab: (0-4-0)
Semesters Offered: Fall, Spring, Summer
Restrictions: May not be enrolled in one of the following Major(s): Mathematics
Pre-Requisite(s): MA 1020 or MA 1030 or ALEKS Math Placement >= 61 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2 or ACT Mathematics >= 22 or SAT MATH SECTION SCORE-M16 >= 540

PH 1110 College Physics I
An overview of basic principles of kinematics, dynamics, elasticity, fluids, heat, thermodynamics, mechanical waves, and interference and diffraction of mechanical waves.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall, Summer
Restrictions: May not be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Major(s): Physics, Construction Management, Surveying Engineering, Electrical Eng Tech, General Technology, Mechanical Engineering Tech, Applied Physics, Computer Network & System Admn
Co-Requisite(s): PH 1111
Pre-Requisite(s): MA 1031 or MA 1032 or MA 1120 or MA 1135(C) or MA 1160(C) or MA 1161(C) or MA 1121(C) or ALEKS Math Placement >= 76 or CEEB Calculus AB >= 2 or CEEB Calculus BC >= 2 or CEEB Calculus AB Subscore >= 2 or ACT Mathematics >= 26 or SAT MATH SECTION SCORE-M16 >= 610

PH 1111 College Physics I Laboratory
Experiments covering kinematics, forces, conservation of momentum and energy, waves, and thermodynamics are explored through guided construction. The course provides inquiry-based laboratory experiences for concepts explored in PH1110.
Credits: 1.0
Lec-Rec-Lab: (0-0-2)
Semesters Offered: Fall, Summer
Restrictions: May not be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Major(s): Physics, Construction Management, Surveying Engineering, Electrical Eng Tech, General Technology, Mechanical Engineering Tech, Applied Physics, Computer Network & System Admn
Co-Requisite(s): PH 1110

II. Courses Core to the Degree

FW 1050 The Natural Resources Professional
Seminar introduces students to the various careers within forestry, conservation, ecology, and wildlife that represent specialties within natural resources. Students explore natural resource issues around the world, and practice effective written and communication skills.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring

FW 2100 Introduction to Biochemistry
Course added in whitebook

FW 2051 Field Techniques
Equipment and techniques used in forestry, wildlife, ecology, and recreation management. Topics include field safety, land measurement and navigation, establishment of sample locations, measurement of attributes of individuals and groups of trees, vegetation and other organisms.
Credits: 2.0
Lec-Rec-Lab: (1-0-3)
Semesters Offered: Fall

FW 2060 Fundamentals of Environmental Sustainability
The four scientific principles of sustainability (reliance on solar energy, biodiversity, nutrient cycling, population control) are the foundation of the course. The course applies basic principles of physics, chemistry, and biology and a systems approach to provide students with a fundamental understanding of how the environment functions and strategies for sustaining natural resources.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand
Restrictions: May not be enrolled in one of the following Class(es): Freshman
Pre-Requisite(s): (MA 1030 and MA 1031) or MA 1032 or MA 1120 or MA 1135 or MA 1160 or MA 1161 or MA 1121 and (CH 1150 and CH 1151)

FW 3760 Human Dimensions of Natural Resources
Uses sociological concepts to cover facets of human relationships to natural resources, including human values, beliefs, and attitudes regarding the environment; rural resource-dependent communities; natural resource professions and expert knowledge; and the history of American perspectives on the environment.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

FW 3020 Forest Ecology
Environmental factors and plant and animal characteristics which control composition, structure, and function of forest ecosystems. Emphasis on how ecosystems change across space and time and knowledge needed to sustainably manage forest ecosystems for social, economic, and ecological benefits.
Credits: 3.0

Lec-Rec-Lab: (2-0-3)
Semesters Offered: Fall
Pre-Requisite(s): FW 2010(C) and FW 2051(C)

FW 3110 Natural Resource Policy
Covers concepts related to social systems and natural resources. Offers a survey of natural resource policies and organizations. State and federal levels of policymaking, policy processes, and policy implementation and evaluation as related to natural resource management.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring, Summer

FW 3313 Sustainability Science
Foundational scientific concepts (dynamic systems and catastrophe theory) as applied to socioecological systems. Use of indicators and indices to track progress towards sustainability goals. Review of local, national, and global sustainability policies to avoid catastrophes and guide sustainable development.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall, Spring
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

FW 3330 Soil Science
Introduction to the chemical, physical, and biological properties of soil.
Credits: 4.0
Lec-Rec-Lab: (3-0-3)
Semesters Offered: Fall
Pre-Requisite(s): CH 1112(C) or (CH 1150(C) and CH 1151(C))

FW3540 Introduction to GIS for Natural Resources
The fundamentals of GIS and its application to natural resource management. Spatial data, its uses and limitations are evaluated. Students work extensively with the ARCGIS software package.
Credits: 4.0
Lec-Rec-Lab: (3-0-3)
Semesters Offered: Spring
Pre-Requisite(s): MA 2710(C) or MA 2720(C) or MA 3710(C) or ENVE 3502 or CEE 3502(C)

FW 4081 Circular Economy
The circular economy is an emerging cross disciplinary field of study that maps a transition from current linear and unsustainable practices, role of consumers, policy, business models, bioeconomy, design, innovation and technological accelerators.
Credits: 3.0
Lec-Rec-Lab: (1-2-0)
Semesters Offered: Spring, Summer
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore

FW 4111 Indigenous Natural Resource Management
In this course, students gain knowledge in indigenous history, culture, and policy to enhance understanding of the rights and privileges associated with treaties, government-to-government

relationship, and diversity of people, practices and values. Students engage in multidisciplinary scholarship with relevance for today's shared management regime.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

FW 4710 Environmental Biogeochemistry
Impacts of decisions regarding landuse, land management, and energy and mineral exploration on natural resources (i.e., air, water, land, and biodiversity) are discussed using the framework of the biogeochemical cycles of the elements.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore
Pre-Requisite(s): CH 1150

BL 3310 Environmental Microbiology – note includes lab – would need to change prereqs (some already do not require bio lab)
General principles of microbiology, focusing on both the use and control of microorganisms. Topics include microbial structure, function, growth, metabolism, and diversity, as well as microbial involvement in water and waste treatment, waterborne diseases, and pollution control. Not open to students with credit in BL3210.
Credits: 3.0
Lec-Rec-Lab: (2-0-3)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore
Pre-Requisite(s): BL 1020 or BL 1040 or BL 3080 or (BL 1200 and BL 1210) or (BL 1400 and BL 1410)

SS 3520 U.S. Environmental History
Examines how human interaction with physical environment has changed in North America over the last four centuries. Topics include uses of land by Native Americans, changes associated with European colonization, incorporation of natural resources into industrial economy, early conservation and preservation movements, and environmental concerns accompanying urbanization and industrialization.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall
Restrictions: May not be enrolled in one of the following class(es): Freshman
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

III. Courses required in at least one of the tracks

GE 2640 Atmospheric Observation and Meteorology
Introduction to fundamentals of atmospheric science and meteorology through direct observations of the atmosphere.
Credits: 3.0

Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall - Offered alternate years beginning with the 2002-2003 academic year

PH 1200 Physics by Inquiry II
Experiments covering Coulomb's law, electric and magnetic fields, circuits, induction, and geometric optics are explored through guided construction. The course emphasizes understanding physical concepts through inquiry and the scientific method.
Credits: 1.0
Lec-Rec-Lab: (0-0-2)
Semesters Offered: Fall, Spring, Summer
Pre-Requisite(s): PH 1100 or PH 1111 or PH 1141 or PH 1161

PH 1210 College Physics II
An overview of basic principles of static and dynamic electricity and magnetism, electromagnetic waves, reflection and refraction of light, interference and diffraction of light, special theory of relativity, wave theory of matter, particle theory of electromagnetic waves, theory of the atom, the nucleus, and elementary particles.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring, Summer
Restrictions: May not be enrolled in one of the following College(s): College of Engineering; May not be enrolled in one of the following Major(s): Physics, Construction Management, Surveying Engineering, Electrical Eng Tech, General Technology, Mechanical Engineering Tech, Applied Physics, Computer Network & System Admn
Pre-Requisite(s): PH 1200(C) and (PH 1110 or PH 1100)

MGT 2000 Team Dynamics and Decision Making
Develops individual and group problem-solving skills using active, hands-on learning. Emphasizes problem identification and problem solution under conditions of ambiguity and uncertainty. Stresses creativity, interpersonal skills and skill assessment, communication, group process and teamwork, and action planning.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Fall, Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman

FW 3410 Conservation Biology
Introduction to biological, social, political, and economic facets of conservation biology. Emphasizes evaluation of how best to maintain and restore biodiversity through management of populations and ecosystems. Topics include mass extinctions, global change, loss and degradation of habitat, and over exploitation of biological resources.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring

FW 4070 - Ge-izhi-mawanji'idiyang dazhindamang gidakiiminaan (the way we meet to talk about our earth)
This course invites Ojibwa community guests to share cultural, ecological, and governance knowledge with students who will develop a better understanding of our shared environment, career and higher education opportunities, and will be better prepared for engaging with and as natural resource and environmental science professionals.
Credits: 2.0
Lec-Rec-Lab: (2-0-0)
Semesters Offered: Spring

FW 4180 Ethics of Conservation and Sustainability
Discusses relationship between ecological science and environmental ethics as it relates to natural resource management, conversation and sustainability.
Credits: 2.0
Lec-Rec-Lab: (0-2-0)
Semesters Offered: Fall
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore

FW 4220 Wetlands
Study of the physical, chemical, and biological characteristics of wetlands. Describes functions and values of individual wetland types. Presents management of wetlands and laws governing wetlands. Labs concentrate on field techniques used to assess specific plant, animal, soil, and hydrological characteristics of wetlands.
Credits: 4.0
Lec-Rec-Lab: (3-0-3)
Semesters Offered: Fall
Restrictions: May not be enrolled in one of the following Class(es): Freshman

FW 4300 Wildland Fire
Overview of wildland fire based on an understanding of fire history, fuel properties, fire weather, fire behavior, ecological effects and management.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore
Pre-Requisite(s): FW 3020 and (FW 3010 or FW 3012)

FW 4370 Forest and Landscape Hydrology
The course will use a process-based approach to present the physical hydrology, geomorphology and water quality of forested watersheds. Course focuses on the interaction between watershed processes and forest management.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore

FW 4380 Landscape Ecology and Planning
Basic principles of landscape ecology, including pattern, process, and scale. Students will learn how to use quantitative tools to study landscape-scale patterns and processes, and how to apply these principles and tools to conservation, resource management, and planning issues.
Credits: 3.0
Lec-Rec-Lab: (0-3-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore

FW 4540 Remote Sensing of the Environment
Remote sensing principles and concepts. Topics include camera and digital sensor arrays, types of imagery, digital data structures, spectral reflectance curves, applications, and introductory digital image processing.
Credits: 3.0
Lec-Rec-Lab: (2-1-0)
Semesters Offered: Fall
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore

FW 4452/5541 Remote Sensing of the Environment Lab
Applied introductory remote sensing analysis using industry standard software for digital image processing.
Credits: 1.0
Lec-Rec-Lab: (0-0-3)
Semesters Offered: Fall
Co-Requisite(s): FW 5540
Note: undergraduate listing to be added in Fall 2021.

FW 4545 Map Design with GIS
Principles of making maps, from traditional to advanced visualization techniques, that convey information which is useful in decision making at many levels. Focus will be on creating maps using GIS software and digital data. A working knowledge of ArcMap is required.
Credits: 2.0
Lec-Rec-Lab: (1-0-3)
Semesters Offered: Spring - Offered alternate years beginning with the 2017-2018 academic year
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore
Pre-Requisite(s): FW 3540 or FW 5550

FW 4554/5554 GPS Field Techniques
This course will provide hands-on experience with various types of GPS units and different applications of the technology. These applications include planning, data collection, data processing, and data management. Emphasis will be on practical applications of Global Positioning System technology.
Credits: 2.0
Lec-Rec-Lab: (1-0-3)
Semesters Offered: Fall
Restrictions: May not be enrolled in one of the following Class(es): Freshman, Sophomore, Junior
Note: undergraduate listing to be added in Fall 2021.

FW 4421/5421 Climate Change and Management in Great Lakes Forest Ecosystems
Provides an overview of climate change science, effects and adaptation for natural resource management in the Great Lakes region. Students develop climate change adaptation plans for real world forested ecosystem examples and learn how to communicate these climate change projects and plans with stakeholders.
Credits: 3.0
Lec-Rec-Lab: (2-1-0)
Semesters Offered: Spring
Restrictions: Must be enrolled in one of the following Level(s): Graduate
Note: undergraduate listing to be added in Fall 2021.

SS 2300 Environment and Society
Examines social approaches to understanding why environmental problems happen and how environmental problems are resolved. Includes concepts such as sustainability, market-based environmental policies, property systems, and environmental justice. Case studies may include biodiversity, deforestation, climate change, water quality, and toxics.
Credits: 3.0
Lec-Rec-Lab: (2-1-0)
Semesters Offered: Spring, Summer

SS 3110 Food Systems & Sustainability
Compares the embedded nature of culturally defined food production and consumption habits: the crux of nature meeting and mixing with culture. The course features classic food system scholarship as well as emerging topics and contemporary case studies.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

SS 3315 Population, Health, and Environment
This course investigates relationships between the world's population, population change, population distribution, resource consumption, and environmental, health, and social consequences. Addresses local and global relationships and the population processes (mortality, fertility, and migration) involved.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall, Summer - Offered alternate years beginning with the 2019-2020 academic year
Restrictions: May not be enrolled in one of the following Class(es): Freshman
Pre-Requisite(s): (MA 1030 and MA 1031) or MA 1032 or MA 1120 and UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

SS 3520 U.S. Environmental History
Examines how human interaction with physical environment has changed in North America over the last four centuries. Topics include uses of land by Native Americans, changes associated with European colonization, incorporation of natural resources into industrial economy, early conservation and preservation movements, and environmental concerns accompanying urbanization and industrialization.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall

Restrictions: May not be enrolled in one of the following Class(es): Freshman
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

SS 3630 Environmental Policy and Politics
A broad survey of how environmental policy making actually works in the U.S. Covers both environmental policy processes and politics, and the major environmental policies themselves for control of air pollution, water pollution, hazardous wastes, and other major environmental problems.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring
Restrictions: May not be enrolled in one of the following Class(es): Freshman
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

SS 3750 Social Inequality
A critical assessment of social and cultural processes associated with group-based or categorical patterns of inequality. Examines the creation, persistence, and attempts at reduction of structured inequality based on categorical factors such as social class, race, ethnicity, and gender. May explore other significant sources of social inequality.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall - Offered alternate years beginning with the 2017-2018 academic year
Restrictions: May not be enrolled in one of the following Class(es): Freshman
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

SS 3801 Science, Technology, & Society
Examines the relationship between science, technology, society, and the environment. Topics may include effects of technologies such as computers, biotechnology, and chemicals on society and nature, science and technology policy, and the history of technology and its global consequences.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Fall, Summer
Restrictions: May not be enrolled in one of the following Class(es): Freshman
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

SS 3805 Environmental Justice
This course focuses on the histories, theories, and practices of environmental justice in local, national, and global contexts. Topics to be explored include environmental racism, industrial facility siting, sustainable development, as well as food, energy, and climate justice.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: Spring - Offered alternate years beginning with the 2021-2022 academic year
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

SS 3815 Energy and Society
This course reviews extent that our lives are integrated with energy production and consumption, and related problems and solutions in our interwined energy and social systems.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)

Semesters Offered: Fall - Offered alternate years beginning with the 2019-2020 academic year
Pre-Requisite(s): UN 1015 and (UN 1025 or Modern Language - 3000 level or higher)

SS 4400 Environmental Sociology
Examines changing relationships between social systems (government, economy, etc.) and the environment. Explores the structural and cultural causes and consequences of such topics as production, consumption, population, energy systems, climate change, pollution, and environmental justice and how to respond to these issues through policies and actions.
Credits: 3.0
Lec-Rec-Lab: (3-0-0)
Semesters Offered: On Demand - Offered alternate years beginning with the 2022-2023 academic year
Restrictions: Must be enrolled in one of the following Class(es): Freshman
Pre-Requisite(s): SS 2700 or SS 2400

Appendix D – Course Add Proposals

Michigan Tech

— Course Add Proposal —

PLEASE COMPLETE THIS FORM IN RED

A guide for completing this form is located at http://www.mtu.edu/registrar/faculty-staff/course-proposal/

1) Course Information

Is this a **half-semester course proposal?** ☐ Yes ■ No

NOTE: All half-semester courses must follow rules set in Faculty Senate Proposal 4-00. See Senate website for details: http://www.sas.it.mtu.edu/usenate/propose/03/10-03.htm

Course Prefix/Number *(i.e. MEEM 2110):* FW4XXX

Course Title *(abbreviated; used on transcript - Up to **30** characters including spaces)*

ESS Capstone

Alternative Title for Catalog *(Up to **100** characters including spaces)*

Environmental Science & Sustainability Capstone

2) Credits

Number of credits assigned to this course 3

OR

Range of credits if **variable** ☐ to ☐ *(Number of credits to be taken in a given semester)*

3) Schedule

Contact Hours per Week *(Lec & Rec: 1 credit =1 contact hour; Lab: 1 credit =1-3 contact hours. (i.e. a 3-credit course may be 2 contact hours of lecture or recitation and up to 3 contact hours of lab OR 1 contact hour of lecture or recitation and up to 6 contact hours of lab)*

1	2	
Lecture	Recitation	Lab

OR

Research Course? ☐ Yes ☐ No

OR

Special Topics Course? ☐ Yes ☐ No

4) Additional Credits

May students receive **additional credits** by taking and passing this course more than once?

■ No

☐ Yes, for a maximum of_____credits. *(Must be a multiple of the course credits, i.e. Research or Special Topics)*

☐ Yes, for an unlimited number of credits. *(i.e. Music, Varsity sports, etc.)*

5) Pass/Fail

Will this course be offered as a **pass/fail option ONLY**? *(grade of S or E)* ☐ Yes ☒ No

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6) Cross/Dual Listed Course

Cross Listed: Is there an identical course offered in a different subject? ☐ Yes ☐ No

If yes, what is the other subject and course number? _____

Dual Listed: Is there a course offered at a different level? ☐ Yes ☒ No

If yes, what is the other course number? _____

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7) Equivalent Course: Does this course replace a dropped course with no change in course content for degree requirements, prerequisites, and repeating purposes? ☐ Yes ☒ No

If yes, what is the subject and course number of the dropped course? _____

8) Corequisites and Prerequisites

Corequisites are courses that are **REQUIRED to be taken at the SAME TIME** as this course (courses MUST be offered during the same term):

Required corequisite course(s):

_____

_____

Prerequisites are courses that are **REQUIRED to be taken PRIOR** to enrollment in this course.
Select appropriate box and use parentheses where needed.

Required prerequisite course(s):

1_____

☐ And ☐ Or 2_____

☐ And ☐ Or 3_____

☐ And ☐ Or 4_____

☐ And ☐ Or 5_____

☐ And ☐ Or 6_____

A **concurrent prerequisite** is a defined prerequisite course (from list above) that **MAY** be taken **EITHER** simultaneously in the same semester **OR** in a prior semester. Indicate below applicable courses.

Concurrent prerequisite course(s):

_____

_____

_____

9) Catalog Course Description

The traditional catalog style description for a course is limited to **350 characters including spaces**. If course is proposed as a half-semester course, please include that information in the description. **Please refer to the Course Proposal Guide for examples and suggestions on developing a course description.**

This course is a capstone experience in which students will identify, research and report on a current issue in environmental science and sustainability. Students draw on the knowledge and experiences in previous courses in the major to synthesize broad perspectives on contemporary issues, and communicate this work in writing and as an oral present

10) Registration Restrictions

- If permission is **always required** for registration purposes (a student cannot enter the course without department or instructor signature)**,** please select the appropriate permission.

  Do not select unless EVERY STUDENT must get "SIGNED INTO" the class.

  ☐ Department **OR** ☐ Instructor

- Students who register for this course may be restricted by their **College/School OR** their **Major**. Please indicate if any college or major restrictions should be applied to this course. If there are no restrictions please indicate in the check box provided.

☐ **No College/School Restrictions**

Colleges/Schools who MAY NOT enroll (EXCLUDE)

-OR-

Colleges/Schools who MAY enroll (INCLUDE)

CFRES

☐ **No Major Restrictions**

Majors that MAY NOT enroll (EXCLUDE)

-OR-

Majors that MAY enroll (INCLUDE)

Environmental Science and Sus

-- Restrictions continued on next page --

- A restriction may also be placed on **Class Standing** (freshman, sophomore, junior, senior, graduate). Please indicate if any class restrictions should be applied to this course. If there are no restrictions please indicate in the check box provided.

☐ **No Class Restrictions**

Class of students who MAY NOT enroll (EXCLUDE)

_____

-OR-

Class of students who MAY enroll (INCLUDE)

Senior

---

11) Semester(s) Offered

☐ Fall ☒ Spring ☐ Summer *(Check all that apply)*

OR ☐ On Demand

If offered in a specific semester, will the course be offered only in alternate years? ☐ Yes ☒ No

If yes, what will be the starting academic year? *(i.e. 2014-15 or 2015-16)*_____

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12) General Education

Is this course being proposed for General Education? ☐ Yes ☒ No

Proposal forms are available at: http://www.mtu.edu/registrar/faculty-staff/course-proposal/.

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13) Course Computing Lab and Expendables Fees

DO NOT RECORD FEE INFORMATION HERE. Submit new course fee information on the New Course Fees Form available at: http://www.mtu.edu/registrar/faculty-staff/course-proposal/.

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14) Course Learning Objectives (Required)

Upon successful completion of this course, students will be able to:

Evaluate a contemporary issue in the area of Environmental Science and Sustainability.
Communicate about the issue they have evaluated using written and oral communication.

15) Degree Programs which this course will affect

List the degrees, minors, and certificates in which this course will be required or used as an elective: ***

Degree Program(s):

Environmental Science and Sustainabilit

***** Be sure to adjust the appropriate degree audits in sections 7 and 8 in your department's binder.**

***16)* Course Rationale** *(Required)*

This class is the capstone class for students completing the BS in Environmental Science and Sustainability. Its enables students to demonstrate that they can evaluate and report on a contemporary issue in this field.

17) Faculty Contact

Faculty proposing this course *(please print)*

: Name Andrew Storer

Email storer@mtu.edu

DID YOU USE RED INK TO COMPLETE THIS FORM?

IF NOT, PLEASE HIGHLIGHT YOUR ANSWERS SO NOTHING IS MISSED IN PROCESSING.