

# The University Senate of Michigan Technological University

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## PROPOSAL 28-96

### B.S. IN APPLIED ECOLOGY AND ENVIRONMENTAL SCIENCES

#### I. Related Programs

Both the private and public sectors will need a steady flow of broadly-educated ecologists and environmental scientists to cope with increasingly complex environmental problems. In response to this demand, the School of Forestry and Wood Products (SFWP), in collaboration with other academic units at Michigan Technological University, proposes an undergraduate degree program in Applied Ecology and Environmental Sciences. Graduates of the program will be trained to: 1) find appropriate solutions to problems posed by development, 2) protect the integrity of ecosystems, and 3) develop and implement methods for ensuring the sustainability of natural resources.

The program will provide students with a broad educational experience, emphasizing the development of skills and knowledge in applied ecology, but also addressing the sociological, political, and economic facets of sustainable development. This multidisciplinary preparation will provide students with strong employment potential in a variety of ecological and environmental fields.

Faculty from the SFWP and several other MTU academic units will contribute to this program. The cooperating units include the Departments of Biological Sciences, Social Sciences, Humanities, Civil and Environmental Engineering, and Geological Engineering and Sciences. The program will also capitalize on a variety of corporations, governmental agencies, and nonprofit organizations that deal with environmental concerns in the Upper Great Lakes Region.

The proposed Bachelor of Science degree program in Applied Ecology and Environmental Sciences is compatible with Michigan Tech's university-wide Initiative for the Environment and strategic goal of enhancing existing environmental sciences and engineering programs. It is also compatible with the SFWP's mission of educating students to solve natural resource problems in response to the needs of science and industry. The program is particularly well-suited for the Upper Great Lakes Region, where graduates will help meet the needs of resource-based industries, governmental agencies, and nonprofit organizations.

The School of Forestry and Wood Products (SFWP) at MTU, in collaboration with other academic units, is especially well-prepared to fill this conspicuous gap in the undergraduate curriculum. The faculty, curriculum, and other necessary resources are largely in place. The SFWP faculty have distinct strengths in ecology, environmental assessment, environmental policy and economics, and conservation biology. In addition, a substantial fraction of the entering undergraduates in the SFWP have explicitly indicated that their primary motivation for attending MTU was their interest in conservation and environmental studies, despite the fact that no such program is currently offered. Such interest is widespread and growing throughout the Upper Great Lakes Region and across the country. The SFWP currently has cooperative agreements with 24 community colleges scattered throughout the region. These links have provided a steady flow of students into the Forestry program, and will likely be a good source of students for the proposed program as well. The Native American community is another likely target audience. In addition, recruitment of students that do not belong to any specific target audience is projected to be very successful, as it has been in MTU's Environmental Engineering program and in the Ecology Option of the B.S. program in Biological Sciences. The Lake Superior basin, with its important natural and economic resources, is an ideal training ground for applied ecologists.

There is no other program in applied ecology and environmental sciences in the Upper Peninsula, although, in other states, many forestry programs or schools of natural resources offer similar programs that are very successful. The School of Natural Resources and Environment at The University of Michigan has a Resource Ecology Program and Michigan State University offers undergraduate degrees in Fisheries and Wildlife Management and Resources Development. In the Upper Peninsula, Northern Michigan University and Lake Superior State University do not offer programs in applied ecology or environmental science, and related undergraduate programs at these institutions are oriented toward basic biology, wildlife management, or the social sciences. Our program, with its emphasis on environmental assessment, and linkage to engineering disciplines has a distinctly different orientation.

On the MTU campus, the Department of Civil and Environmental Engineering offers one of the best programs in Environmental Engineering in the United States. This program is currently over-subscribed and the new program in Applied Ecology and Environmental Sciences may take some of the enrollment pressure off MTU's Department of Civil and Environmental Engineering. The Department of Biological Sciences currently offers an option in ecology. This option within the Biology degree program has a much stronger emphasis on environmental chemistry and basic biology. It does not emphasize applied ecology or environmental assessment. The new program will nicely complement the Environmental Engineering Program and the ecology option in the Biology Program. Together, new and existing programs can fulfill the vision of a technological university with a strong educational emphasis on solutions to existing and future environmental problems.

## **II. Rationale**

Environmental problems are intimidating in their diversity and complexity. The construction of golf courses, roads, buildings, and manufacturing facilities requires evaluation of environmental impacts. The protection of wetlands is an integral part of land management. Monitoring of air and water quality are important functions in both industry and government. As environmental problems compound and humans strive to sustain and further use natural resources, employment potential will increase for rigorously trained ecologists and environmental scientists. These individuals typically work in concert with civil and environmental engineers, landscape architects, planners, foresters, and wildlife biologists to protect the integrity of the landscape. The broad purpose of the Bachelor of Science degree in Applied Ecology and Environmental Sciences is to equip students with the knowledge, expertise, ethics, and perspective necessary for the resolution of contemporary environmental problems.

This program will uniquely satisfy a strong regional need. This need reflects the resource-based economy of the region. The region's universities currently lack a program comparable to that proposed here, though selected institutions in the region offer successful programs in environmental studies. The proposed program will also satisfy an institutional need; the program's focus is consistent with the MTU Initiative for the Environment. This university-wide mandate has four broad goals: emphasis on environmental issues throughout the undergraduate curricula; promotion of multidisciplinary approaches in an environmental context; focus on the Lake Superior basin as a model; and emphasis on environmental education, research, and service.

Likewise, the philosophy of the program in Applied Ecology and Environmental Sciences is consistent with the stated mission of MTU's undergraduate program in Forestry. The forestry program places a strong emphasis on environmentally responsible forest management. The mission of SFWP is to solve natural resource problems in response to the needs of science and industry. Specifically, the mission of the B.S. in Forestry is to provide graduates with: "an understanding of the structure and function of forest ecosystems, with emphasis on natural processes critical to their long-term health and productivity; knowledge of techniques that can be applied to develop management options for forested landscapes; the ability to use this understanding and knowledge to develop and communicate realistic alternatives for managing forested landscapes; and the ability to work with professionals and concerned publics to implement decisions which meet the needs of society while maintaining the integrity of ecosystems." The proposed program in Applied Ecology and Environmental Sciences will be philosophically consistent with the existing B.S. program in Forestry but will have a different orientation. Instead of training

undergraduates to be environmentally responsible professionals in a specific field, the proposed program will prepare students for a much broader array of professional options. In many fields, such as environmental assessment, graduates of the program will have a strong competitive advantage over graduates of more traditional land management programs, such as forestry or wildlife management.

### **III. Curriculum Design**

The School of Forestry and Wood Products trains both undergraduate and graduate students in ecosystem management, wildlife ecology and management, and forest ecology. To build on this expertise, the proposed curriculum will emphasize coursework in basic and applied sciences, ecology, biology, policy, and environmental studies. The curriculum will be both field-oriented and interdisciplinary in scope. The goals of this curriculum are to train students that:

- i) have a diverse and highly technical background in applied ecology and environmental sciences;
- ii) are able to assess the environmental conditions of both terrestrial and aquatic ecosystems;
- iii) can make land-use decisions that integrate utilization with the maintenance and protection of ecosystem composition, structure and function;
- iv) have the communication skills and professional ethics necessary to work with their peers and other individuals to solve ecological and environmental problems.

To obtain a Bachelor of Science degree in Applied Ecology and Environmental Sciences, students will be required to take a minimum of 21 credits in courses emphasizing Ecological Studies, 32 credits in courses emphasizing Biological Sciences, 34 credits in Chemistry, Physical Sciences, and Mathematics courses, and 40 credits in Related Environmental Studies Courses (Table III.1). These courses will allow students to meet the academic standards for designation as Certified Ecologist by the Ecological Society of America (Appendix C).

University course requirements will be met by requiring students to fulfill General Education Requirements, including credits in Communications, Quantitative Sciences, Humanities, Social Sciences, Physical Education, and Upper-Division Thematic Studies (non-cognate to Forestry and Biological Sciences) (Table III.1). An additional 15 credits of elective courses will be used to strengthen the student's chosen expertise in Applied Ecology and Environmental Sciences. Instead of offering fixed options, electives (in related environmental sciences and free and professional fields of interest) will be selected in consultation with a faculty advisor to meet the needs and career goals of individual students. Relevant areas of concentration could include Biological Sciences, Social Sciences, Civil and Environmental Engineering, or Geological Sciences. A total of 192 credits will be needed to graduate.

Four years will be needed to complete this curriculum. The first year of instruction will be dedicated to taking University-required courses and introductory courses in Biological Sciences, Chemistry, Mathematics, and Physics. Courses taken in the first year will lay the framework for the subsequent years of instruction. Courses in the next three years will emphasize advanced studies in applied ecology, ecological and biological sciences, thematic studies, and electives for a chosen area of concentration. The curriculum will provide students with the necessary background to meet the program's goals.

### **IV. Students**

A significant increase in the number of students coming to Michigan Technological University is expected with the implementation of this program. Presently, the School of Forestry and Wood Products has 135 undergraduate students, 90% of these being in the Forestry Program. Michigan Technological University has a reputation, fostered by students and alumni alike, for being a "tough" University with high standards for graduation. The quality of the School's incoming freshman compares very well with the at-large average for MTU. Students entering MTU average 24.3 on the ACT; those entering the School of Forestry and Wood Products average 23.2. These scores are higher than the Michigan and National averages of 20.2 and 20.3, respectively. This standard will be maintained or enhanced with the addition of this degree program.

Approximately 50% of the School of Forestry and Wood Products undergraduates enter as transfer students. Agreements with 24 community colleges bring students into a 2+2 program into the School, whereby dual degrees are given, one with the cooperating community college (first two years) and one with MTU (second two years). These agreements, along with the implementation of a degree program in Applied Ecology and Environmental Sciences, will attract more students from regional community colleges with compatible two-year programs. It is anticipated that similar 2+2 programs will be established with other interested institutions for the B.S. in Applied Ecology and Environmental Sciences. This program will strengthen the bond between MTU and community colleges in the Upper Great Lakes Region.

The School of Forestry and Wood Products has had a Recruitment and Retention Committee for over seven years. This has helped not only to increase our recruiting efforts, but to maintain consistent quality in our recruiting and retention activities. These efforts will continue in the future, and will enhance the new program by providing an existing framework for recruiting new students.

Every student accepted into the School of Forestry and Wood Products is offered financial aid from various sources: the School, various faculty on research projects, and/or the MTU Financial Aid Office. A minimum of \$500 as a work-study grant is offered to all incoming students. Many of our students utilize these grants by working with faculty on research grants dealing with applied ecology and environmental issues. The professional and personal experiences gained from this opportunity provide our students a unique advantage over students in other programs throughout the Upper Midwest. Over 30 additional scholarships are given annually by the School of Forestry and Wood Products to qualifying students; they range in value from \$100 to \$1000. Efforts will be made to acquire additional scholarships for students in the Applied Ecology and Environmental Sciences program. The School's Advancement Officer will work closely with faculty to provide additional scholarship opportunities.

Students are provided an environment that encourages development of leadership capabilities and professional ethics, and encourages them to take responsibility for their actions and their personal and professional growth. To help students in these endeavors, various student organizations are available including Xi Sigma Pi -- the national forestry honorary society, the MTU Forester--the only departmental yearbook produced annually at MTU, the Student Chapter of the Society of American Foresters, the Student Chapter of the Wildlife Society, and a Chapter of the Timber Wolf Alliance. Students are also encouraged to attend local and regional professional meetings and to interact with professionals in seminars, courses, and the School's Advisory board meetings. Funding is often available for travel to these functions, which are often held in the Upper Peninsula. Such professional meetings provide a rich opportunity for undergraduates to associate with practicing professionals. Students in this degree program will be encouraged to gain some of their professional work experience by working for ecological and environmental agencies during the summer, by taking a quarter to work abroad on various ecological/environmental projects, or by taking a quarter to work as an intern or in cooperative programs established by the School and outside organizations.

## **V. Careers in Applied Ecology and Environmental Sciences**

A Bachelor of Science Degree in Applied Ecology and Environmental Sciences will prepare students for a variety of career options. Many students will find employment in the private sector. Sustainable development will depend, in part, on personnel that understand how to maintain the integrity of ecological systems. The National Environmental Policy Act (1969) guides the assessment of human manipulations of the landscape; corporations are increasingly realizing the need for staff with the technical expertise necessary to comply with environmental regulations. In addition to working directly for corporations, many graduates will find employment with private consulting firms engaged in environmental assessment. This type of employment spans the entire range of the private sector from firms involved in the construction of golf courses, roads, buildings and recreational facilities, to those developing major new manufacturing facilities. A four-year degree in Applied Ecology and Environmental Sciences will enable graduates to work directly with engineers in making the environmental assessments necessary to implement construction projects.

Many students will choose to work for state and federal agencies. Again, there are numerous employment opportunities. Examples include the determination of wetland status, monitoring of air and water quality, soil conservation, and monitoring of biological diversity. Students who successfully complete the program of study will meet the academic standards for achieving Certified Ecologist status from the Ecological Society of America. Ecologists are employed by many state and federal agencies, including the USDA Forest Service, the Environmental Protection Agency, the United States Fish and Wildlife Service, the National Biological Service, the Michigan Department of Natural Resources, the Michigan Department of Environmental Quality, and the Michigan Department of Transportation. Many students will, no doubt, also find employment in other states.

Some students will also find employment with non-profit organizations like the Nature Conservancy, Sierra Club, and Audubon Society. Again, their training in basic ecology and environmental studies will enable them to make ecological assessments.

As an alternative to treating the B.S. in Applied Ecology and Environmental Sciences as a terminal degree, students will also be well-positioned to attend graduate school. The fundamental training these students receive will enable them to complete graduate degrees in a variety of natural resources and environmental policy programs or to pursue a law degree. Because of the high caliber of students that Michigan Technological University attracts (ACT scores of 24.3, above the national average of 20.3), and the rigor of this degree program, students will be able to specialize at the graduate level to assume a variety of positions of responsibility. Graduate programs in ecology, environmental engineering, conservation biology, and environmental policy are all expanding to meet the needs of humans as they learn to sustain their life-support systems. Students at MTU are educated in a culture of problem-solving with an emphasis on technological solutions to problems. This program conforms well with the mission of MTU and its current emphasis on the environment.

## **VI. Institutional Resources**

The administration of the proposed Bachelor of Science in Applied Ecology and Environmental Sciences program will be as described in Section VII. Briefly, the program will be housed and administered in the School of Forestry and Wood Products. Students will be exposed to coursework, faculty, and research being conducted in a number of supporting programs at MTU.

### **A. School of Forestry and Wood Products**

The mission of the MTU School of Forestry and Wood Products is to solve natural resource problems in response to the needs of science and industry. Implicit in this statement is the belief that a major part of the School's mission is to provide graduates with a general university education as well as knowledge and skills in the historical, ethical, conceptual, and practical bases of forestry and wood science, so they can effectively communicate this information to others and contribute to continued development of their profession. The development of a B.S. in Applied Ecology and Environmental Sciences is consistent with this mission and will provide a broadening of the scope of the undergraduate programs within the School. The research mission of the School is to develop and assess means for more efficient management and utilization of forest resources while maintaining a clean environment, coupled with the maintenance of ecosystem diversity, stability, and integrity. The proposed B.S. program dovetails with this mission with undergraduates in the program having the opportunity to work with and learn from faculty and researchers in the School and across campus.

**Academic Programs.** The School of Forestry and Wood Products currently offers the following degree programs:

Bachelor of Science in Forestry. The baccalaureate degree program in forestry introduces students to all aspects of the profession. After completing a core of courses in basic forestry, science, communications, mathematics, and economics, students choose electives from the following specializations: ecosystem management, wildlife ecology and management, or forest ecology. During the fall quarter of their

sophomore year, students devote their time to a field practicum at the Ford Forestry Center, becoming familiar with such activities as site quality estimation, mapping, estimating tree growth, and log scaling and grading.

**Bachelor of Science in Wood Science.** This program provides a comprehensive knowledge of the physical, mechanical, and chemical attributes of wood. Students can choose from four areas of concentration: environmental remediation, environmental protection, composite materials, or business.

**Master of Science in Forestry.** The M.S. program permits independent study in a broad spectrum of natural resources management or wood science. Interdisciplinary studies are encouraged and may include course work in engineering, business, and science.

**Doctor of Philosophy in Forest Science.** The Ph.D. program allows students to conduct research and pursue in-depth studies in selected areas of forest or wood science. Students enrolling in this program are expected to have demonstrated outstanding ability in previous academic work.

The proposed B.S. in Applied Ecology and Environmental Sciences is a logical extension to the academic programs already offered by the School. This program will broaden and diversify the student body and emphasize more general concepts of ecology and environmental studies.

**Faculty.** All of the faculty in the School of Forestry and Wood Products hold the Ph.D. degree, and many are considered national and international experts. They share a commitment to quality teaching and to providing an excellent learning environment. Active in their professions, the faculty share their expertise and keep current through research and by participating in conferences, presenting seminars, and publishing in professional journals. There are 21 faculty and administrators in the School. The following individuals will be leaders in implementing the B.S. in Applied Ecology and Environmental Sciences; complete curriculum vitae are included in Appendix A.

**Chen, Jiquan.** (B.S., Biology, 1983, Inner Mongolia University; M.S., Forestry, 1986, Chinese Academy of Science; Ph.D., Ecosystem Analysis, 1991, University of Washington). Interests: Landscape ecology, quantitative ecology, microclimatology, conservation biology.

**Desanker, Paul V.** (B.S., Forestry, 1988, University of Aberdeen-Scotland; M.S., Statistics, 1991, Ph.D., Forest Biometrics, 1992, Michigan Technological University). Interests: Multi-resource inventory, ecological modeling, global change, ecosystem dynamics, and climate modeling.

**Framer, W.E.** (B.S., Forestry, 1961, Pennsylvania State University; M.F., Forest Biometry, 1962, D.For., Forest Biometry, 1965, Yale University). Interests: Forest biometry, forest inventory systems, forest survey techniques, wetland inventories.

**Gale, Margaret R.** (B.S., Forestry, 1977, M.S., Forestry, 1980, Michigan Technological University; Ph.D., Production Ecology, 1987, University of Minnesota). Interests: Wetland ecology, root ecology, and growth and yield.

**Halvorsen, Kathleen,** (B.S., Political Economy of Natural Resources, 1989, University of California at Berkeley; M.S., Environmental Sciences, 1992, SUNY; Ph.D., Forest Resource Management, 1995, University of Washington). Interests: Sociology of natural resources; natural resource and environmental policy; ecosystem management.

**Jurgensen, Martin F.** (B.S., Forestry, 1961, M.S., Silviculture, 1965, State University of New York-Syracuse; Ph.D., Soil Science, 1967, North Carolina State University). Interests: Forest soils, soil microbiology, nutrient cycling.

**Karnosky, David F.** (B.S., Forestry, 1971, M.S., Forest Genetics, 1972, Ph.D., Forestry and Forest Genetics, 1975, University of Wisconsin-Madison). Interests: Forest tree improvement, tissue culture, air pollution effects on trees.

**Maclea, Ann L.** (B.S., Forestry, 1976, Michigan Technological University; M.S., Forestry, 1984, M.S., Remote Sensing, 1984, Ph.D., Remote Sensing, 1987, University of Wisconsin-Madison). Interests: Remote sensing in forestry, digital image processing, aerial photography and interpretation.

**McGinnis, Gary D.** (B.S., Chemistry, 1962, Pacific Lutheran University; M.S., Organic Chemistry, 1968, University of Washington; Ph.D., Carbohydrate Chemistry, 1970, University of Montana). Interests:

Environmental control and remediation, composite board production, chemical biomass conversion.

**Mroz, Glenn D.** (B.S., Forestry, 1974, M.S., Forest Soils, 1976, Michigan Technological University; Ph.D., Silviculture/Soils, 1983, North Carolina State University). Interests: Hardwood silviculture, forest soils, wetland silviculture.

**Orr, Blair D.** (B.S., Natural Resources, 1977, M.A., Economics, 1986, Ph.D., Forestry, 1988, University of Wisconsin-Madison). Interests: Economics, international forestry.

**Peterson, Rolf O.** (B.S., Zoology, University of Minnesota-Duluth; Ph.D., Wildlife Ecology, 1974, Purdue University). Interests: Wildlife management and ecology, animal behavior, and population dynamics.

**Pickens, James B.** (B.S., Biology, 1975, Eastern Montana College; M.S., Forest Biometrics, 1980, Ph.D., Forest Management, 1985, University of Georgia). Interests: operations research, statistics, economics.

**Pregitzer, Kurt S.** (B.S., Forest Management, 1975, M.F., Forest Management, 1978, Ph.D., Forest Ecology, 1981, University of Michigan). Interests: Forest ecology, landscape ecology, ecosystem processes, global change, conservation of natural resources.

**Reed, David D.** (B.S., Forest Science, 1977, University of Arkansas-Monticello; M.S., Forest Biometrics, 1979, M.S., Statistics, 1982, Ph.D., Forest Biometrics, 1982, Virginia Polytechnic Institute and State University). Interests: Forest measurement, growth and yield, mathematical modeling.

**Shetron, Stephen G.** (B.S., Soil Science, 1958, M.S., Soil Science, 1960, Michigan State University; Ph.D., Forestry, 1969, University of Michigan). Interests: Forest soils, soil development, classification, and interpretation for forest land use, reclamation of disturbed lands.

**Waite, Thomas A.** (B.S., Zoology, 1981, University of Maine; M.S., Zoology, 1986, Ph.D., Zoology, 1991, Ohio State University). Interests: Behavioral ecology, conservation biology, ornithology.

In addition to the resident faculty, a strong adjunct faculty has enhanced the program of research and graduate studies. Through visits to campus, seminars, and other means, it is expected that these individuals will also contribute to the education of students pursuing the B.S. in Applied Ecology and Environmental Sciences.

**Bradshaw, Gay A.** (Ph.D., Oregon State University). Interests: Image analysis, geographic information systems, spatial analysis, landscape ecology.

**Crow, Thomas R.** (Ph.D., University of Minnesota). Interests: Plant ecology and physiology, biodiversity, landscape ecology.

**Graham, Russell T.** (Ph.D., University of Idaho). Interests: Silviculture, tree regeneration.

**Grigal, David F.** (Ph.D., University of Minnesota). Interests: Forest and wetland ecology, carbon and heavy metal dynamics.

**Harvey, Alan E.** (Ph.D., Washington State University). Interests: Plant pathology and soil microbiology.

**Heyd, Robert L.** (Ph.D., Michigan State University). Interests: Forest insect and disease monitoring and control.

**Isebrands, Judson G.** (Ph.D., Iowa State University). Interests: Tree physiological processes.

**Larsen, Michael J.** (Ph.D., State University of New York). Interests: Forest mycology and pathology.

**Lautenschlager, R.A.** (Ph.D., University of Maine). Interests: Wildlife ecology, forest resource management, forest ecology.

**Leary, Rolfe A.** (Ph.D., Purdue University). Interests: Tree growth modeling, application of systems analysis and quantitative modeling of forest management.

**Maclean, Gordon L.** (Ph.D., University of Wisconsin-Madison). Interests: Remote sensing, digital image processing, geographic information systems.

**Neary, Daniel G.** (Ph.D., Michigan State University). Interests: Ecological impacts of intensive silviculture.

**Page-Dumroese, Deborah S.** (Ph.D., University of Idaho). Interests: Forest soils, tree physiology.

**Podila, G. Krishna.** (Ph.D., Indiana State University). Interests: Molecular basis of plant-microbe interactions, forest biotechnology.

**Premo, Bette J.** (Ph.D., Michigan State University). Interests: Limnology, water quality, plant ecology.

**Premo, Dean B.** (Ph.D., Michigan State University). Interests: Plant ecology, water quality, landscape ecology.

**Richter, Dana L.** (Ph.D., Michigan Technological University). Interests: Forest pathology, tree root biology, mycology, forest soil microbiology, wood decay, mycorrhizae.

**Rogers, Elizabeth I.** (Ph.D., Michigan State University). Interests: Ornithology, wildlife ecology, landscape ecology.

**Sharik, Terry L.** (Ph.D., University of Michigan). Interests: Forest ecology, regeneration of hardwood and conifers following disturbance, forest-wildlife-habitat relationships.

**Trettin, Carl C.** (Ph.D., North Carolina State University). Interests: Carbon and nitrogen dynamics in forested wetlands, effects of silvicultural practices on soil processes, functional ecology of wetland landscapes.

**Witter, John A.** (Ph.D., University of Minnesota). Interests: Forest entomology and acid rain.

## **B. Supporting Programs at MTU**

Almost every academic unit at MTU offers coursework relevant to students pursuing the B.S. in Applied Ecology and Environmental Sciences. The following departments, especially, will provide academic support for students pursuing this degree. Almost all of these departments offer M.S. and Ph.D. degrees in their respective fields; the emphasis here is on their undergraduate degree offerings.

**Department of Biological Sciences.** The Department of Biological Sciences provides instruction and training through a curriculum that incorporates critical thinking and problem solving as well as communication skills. The Department offers undergraduate programs leading to the B.S. in Biological Sciences and the B.S. in Clinical Laboratory Science. Specific options within biological sciences are general biology, ecology, microbiology, molecular biology, plant sciences, and preprofessional studies. An honors in biological sciences program is available for qualified students who are willing to conduct independent research projects during their senior year. There is a dual degree program in Environmental Biology and Engineering offered in cooperation with the Department of Civil and Environmental Engineering.

**Department of Social Sciences.** The Department of Social Sciences offers two degree programs at the undergraduate level: B.S. in Social Sciences (General and Science, Technology, and Society options), and Bachelor of Liberal Arts (History option). Courses in natural resource policy are cross-listed in the School of Forestry and Wood Products and the Department of Social Sciences and there is currently one joint faculty position (two-thirds in the Department of Social Sciences and one-third in the School of Forestry and Wood Products).

**Department of Civil and Environmental Engineering.** The Department of Civil and Environmental Engineering offers a B.S. in Environmental Engineering degree program. Emphasis is on the control of environmental pollution through prevention, pollutant removal and destruction, and modeling of natural systems; areas of course work and research can be broadly classified as: 1) engineering of process systems to control environmental pollution, 2) analysis and modeling of the impact of pollutants on the environment, and 3) waste minimization/source reduction.

**Department of Geological Engineering and Sciences.** The Department of Geological Engineering and Sciences offers B.S. programs in Geological Engineering, Geology, and Applied Geophysics. The B.S. in Geology has options in Geology and Environmental Geology.

## **C. Physical Facilities**

The School of Forestry and Wood Products is located in several facilities: the U.J. Noblet Forestry and Wood Products Building, the Widmaier House, the Anderson House, the Forestry Annex, the Ford Forestry Center located 42 miles south of Houghton, and the Isle Royale Sands Research Facility on the main campus. In addition, the School is leasing 870 square feet of office and laboratory space from the U.S. Forest Service. The School occupies a total of 41,829 square feet of office and laboratory space on campus. A detailed description of the physical facilities is presented in Appendix B.

**D. Library Resources** Library facilities serving the MTU campus are located in the University Library and in storage facilities (for serial volumes pre-dating 1971) in the Library Annex. The University Library offers a Government Documents and Maps Department, an On-line Search Service, and Interlibrary Loan Services, in addition to Reference, Serial, and Book Holdings. There are over 330,000 volumes in the general collections. A computerized catalog system is accessible through the MTU computing network.

**Government Documents and Maps Department.** The Library has been a designated selective depository for U.S. Government publications since 1876. Roughly 58 percent of Government Printing Office publications are selected for inclusion. As such, complete sets of U.S.D.A. Forest Service, other U.S.D.A., and U.S.D.I. publications are available for academic and research purposes. The number of government documents exceeds 450,000. Translations through the Special Foreign Currency Science Information Program are also received from U.S.D.A.

**University Library Maps Room.** This facility holds over 127,000 maps covering most of the U.S., Canada, and other foreign countries. Holdings include historic, topographic, soils, military, and other environmentally- and ecologically-related maps. All are available for student and faculty/staff use.

**On-line Search Services.** The University Library maintains an efficient Online Computer Search facility. Databases concerning multidisciplinary matters and current affairs, and ongoing and published research, are available for environmentally- and ecologically-related information/literature searches. In addition, the University Library is a member of the Online Computer Library Center (OCLC), a bibliographic database of library holdings. Approximately 100 relevant databases are Online, including Dialogue, Bibliographic Retrieval Services, Systems Development Corporation, Chemical Abstract Service On-Line, National Institutes of Health/Environmental Protection Agency, National Library of Medicine, and Info-Line.

**Interlibrary Loan Service.** The University Library provides interlibrary loan privileges to obtain printed material not available at MTU. Policies are based on the National Interlibrary Loan Code established by the American Library Association.

**Reference Holdings.** Indexing services provided by the University Library of special interest to the proposed B.S. program are the Science Citation Index, the U.S.D.A. Bibliography of Agriculture, Forestry Abstracts, Wildlife Abstracts, Biological and Agricultural Index, Biological Abstracts, Institute of Paper Chemistry Bulletin, Chemical Abstracts, Bibliography and U.S. Patents, and Dissertation Abstracts. National, trade, and subject bibliographies in the collections include the Dictionary Catalog of the Yale Forestry Library, Dictionary Catalog of the National Agricultural Library, Dictionary Catalog of the Department of Interior Library, Cumulative Book Index, British Union Catalog, and the Library of Congress Catalog Books.

**Serial Holdings.** The Library currently subscribes to approximately 3,700 serial publications, many of which support the ecology and environmental science academic and research programs. Approximately 85 percent of the University Library's total annual purchasing budget is spent on acquisition of serial titles.

**Book Holdings.** The School of Forestry and Wood Products receives an annual allotment of approximately \$4,800 for the discretionary purchase of individual volumes (beyond standing orders) dealing specifically with the academic programs of the School. Responsibility for the selection of pertinent volumes rests with the faculty of the School; prioritized lists are coordinated by the School's Library Liaison and the Library Bibliographer. In addition, the Library Bibliographer maintains current research and teaching profiles on each faculty member for the purpose of providing the School with order slips from North American Blackwell which identify recent publications relevant to faculty needs. Quarterly lists of new acquisitions are provided by the library for circulation to faculty members. The University Library presently holds over 11,000 books supporting the academic and research programs of the School of Forestry and Wood Products.

**Voyager and Network Access.** Voyager, the library's online catalog, is a client-server application that provides multiple search options, including subject, keyword boolean, and relevance-ranked searching. It also provides access to other libraries and databases. Voyager is available in Microsoft Windows and ASCII formats, and via the world wide web. The library's web page provides information regarding library services, plus easy access to resources such as ready reference materials, U.S. government publications, and the Michigan Electronic Library (MEL). MEL is a project of Michigan's MLink Program, the Library of Michigan, and the Merit Network. It provides access critical for the citizens of MI (county economic profiles, census data, etc.) a subject listing of resources from around the world, and a user-friendly search engine.

**Other.** The School of Forestry and Wood Products also accesses pertinent literature through membership in the International Union of Forestry Research Organizations (IUFRO) and subscribes to "Current Contents" from the Institute for Scientific Information (both the Biological Sciences and the Agricultural and Life Sciences editions).

**E. Computer Facilities** The MTU computer system is a full member of the MERIT network linking computing facilities at the University of Michigan, Michigan State University, Wayne State University, Oakland University, Western Michigan University, and MTU. MTU maintains a distributed computing policy, where the network backbone, access to outside networks, communications, consulting, and support services are centrally maintained while computing facilities in individual academic and administrative units are maintained locally, usually with an on-site Systems Administrator being responsible for maintenance and consulting.

The School of Forestry and Wood Products computing network supports faculty and staff, administrative, and student use. The network connection is provided by two Sun workstations, one serving the student laboratory and the other faculty and staff. The student microcomputer laboratory contains 30 486 or Pentium PCS, three laser printers, and six Sun workstations. A software library for this laboratory includes several applications programs (word processors, spreadsheets, database management programs, statistical analysis systems, etc.) for student use. Through the MTU network, students have access to electronic mail and centrally supported software (statistical packages, programming languages and compilers, computational packages, etc.). The laboratory has a capacity for 36 students and, when not reserved for regularly scheduled classes, is open on a first come, first served basis. Students are encouraged to use the laboratory for independent study. University computer policy provides for this laboratory to be the major point of access to computing facilities for students in the School of Forestry and Wood Products.

The School of Forestry and Wood Products also maintains an Earth Resources Remote Sensing/Geographic Information System Laboratory. The Laboratory houses six 486 or Pentium PCS plus two Sun workstations. Peripheral equipment includes a digitizer, plotter, 9-track tape drive, two color inkjet printers, high resolution color scanner, two 32-bit high resolution color monitors, four SVGA monitors, a 48-inch color inkjet plotter, and four tape back-up units. Software utilized for teaching and research includes: ERDAS (PC and Sun versions), ARCInfo (PC and Sun versions), ARCView, CADCORE Tracer, dBASE IV, C-Map, Surfer, and GeoBase. The Laboratory also houses a Bausch and Lomb Zoom Transfer Scope. The Laboratory is used for graduate teaching, graduate and faculty research, and limited undergraduate teaching. The major portion of undergraduate instruction in geographic information systems is conducted in the main undergraduate teaching laboratory. Geographic information system support for the MTU Regional GEM (Groundwater Education in Michigan) Center is provided by this Laboratory.

## **VII. Program Administration**

Responsibility for administration of the program will reside with the Dean of the School of Forestry and Wood Products, who reports to the Executive Vice-President and Provost for Academic Affairs. The Dean also serves as Director of the Ford Forestry Center. The Dean has overall responsibility for School performance including: (1) recommendations for hiring and salary increments; (2) recommendations for

promotion, tenure, and termination; (3) evaluation of faculty and staff performance; (4) identifying and pursuing the educational objectives of the School; (5) allocation of budget to line items and approval of expenditures; (6) allocation of space; and, (7) maintaining progress toward fulfillment of the School's mission.

The School of Forestry and Wood Products is governed by its Charter which outlines administrative policies and procedures and the rules for academic governance within the School. Consistent with the Charter, policies on admissions, course offerings, and degree requirements fall under the jurisdiction of the Curriculum Committee. The Curriculum Committee is composed of three faculty members elected by the entire faculty for a period of three years. The Chairperson of the committee rotates to the member in his/her final year of service. Ad hoc subcommittees may be formed by the Dean when substantial changes to degree programs are necessary, but all curriculum changes must be approved by the Curriculum Committee and then by the faculty of the School of Forestry and Wood Products. Substantive changes in course offerings and degree programs must be approved by a majority vote in a regularly scheduled faculty meeting. Changes in the Applied Ecology and Environmental Sciences Program must conform with the rules outlined in the Charter of the School of Forestry and Wood Products. Additional requirements to assure academic quality and the integrity of this new program are outlined in the University and Board of Control Procedures Manuals.

Responsibility for admissions to the Program in Applied Ecology and Environmental Sciences lies with the Admissions Office at Michigan Technological University. Applicants will be judged on the basis of their high-school academic performance, and scores from the Preliminary Scholastic Assessment Test (PSAT), the Scholastic Assessment Tests (SAT), or the American College Test (ACT). Students in good standing (minimum average of 2.5 on a 4.0 scale) at another college may also apply for admission. Admission policies and procedures are outlined in more detail in the Undergraduate Catalog of Michigan Technological University. Once admitted, all students will be assigned an academic advisor and academic progress will be monitored following standard MTU protocols.

## **VIII. Program Costs**

At this time, no start-up costs are needed for this program. As the program grows, however, additional resources will be needed and are outlined below.

The School of Forestry and Wood Products already has an excellent cadre of faculty members with expertise in the areas covered by the proposed program. In the past three years three new Ph.D. ecologists have joined the School to complement a program traditionally strong in this area. The new program also dovetails nicely with the campus-wide Initiative for the Environment and MTU's Strategic Plan: 1998 and Beyond. The program will be able to draw upon the expertise of environmental sciences faculty and course offerings in several complementary programs at MTU, including: The Department of Social Sciences, with its emphasis on environmental policy; the Department of Biological Sciences, with its expertise in basic biology, limnology, ecology and the Lake Superior Ecosystems Research Center; the Department of Civil and Environmental Engineering, with one of the best programs in environmental engineering nation-wide; and the Department of Geological Engineering and Sciences, with its emphasis on atmospheric and environmental studies and its strong program in remote sensing. Consistent with its mission, MTU is a leader in the application of remote sensing and computer technology in the environmental sciences. Requests for institutional support are linked to projected enrollments through time, with initial support going primarily to the Department of Biological Sciences. The enrollment break-points are 35 students in the initial 2-3 years, 50 students for a GIS lecturer, and 75 students before any new faculty positions are justified. If enrollments increase faster or slower than anticipated, resources would be allocated in proportion to the increase in enrollment.

### **A. Biological Sciences**

We predict 35 new students in the first two years. This will increase the teaching loads in BL104, BL216, BL217 and BL340 and would add an estimated nine laboratory sections per year to the required

Biological Sciences courses. One new graduate TA is requested to support this additional load. Additional teaching responsibilities in Biological Sciences will also occur as the new students choose elective courses as explained in the Curriculum Design section. Thus, 35 students would require the additional support of a total of 1.5 to 1.7 GTA's in the Department of Biological Sciences. When the enrollment increases to 75 students, a new faculty member would be required in the Department of Biological Sciences along with additional GTA support. At that time, the faculty position will be described in joint discussions with the SFWP, and the SFWP will have a minority position on the search committee.

## **B. School of Forestry and Wood Products**

At this time, no new faculty are requested. We anticipate the need for a certified GIS lecturer when enrollment in this program reaches 50 students (master's or Ph.D. degree, non-tenure track). Geographic information systems are a rapidly expanding technological tool in the environmental sciences, and their utilization to monitor natural resources, plan for construction projects, and inventory and simulate resource status will be an integral part of our new program. These technological tools have a strong place at MTU, the Upper Midwest's only technological university. When student enrollment reaches 75, a new position will be filled in the tentative area of quantitative ecology.

## **C. Computer Equipment**

When the number of students in the program exceeds 35, a capital outlay of \$50,000 in each of two successive academic years will be needed. This will be sufficient to handle at least 100 students in the degree program and will be needed to expand our remote sensing and geographic information system laboratory. This laboratory was recently remodeled and expanded with both intra- and extramural resources, but our need in this area is expanding rapidly. This capital outlay of \$100,000 over two academic years will enable us to improve our ability to teach advanced undergraduate students the computer applications and skills they will need to acquire professional employment. Our goal is to be at the cutting-edge of the application of remote sensing and computer technology in the environmental sciences. The replacement and updating of the new equipment and software over the long-term will be accomplished through laboratory and computing fees. At MTU there is a campus-wide procedure for the maintenance of central computing facilities; the Computer Fee Subcommittee of the Computer Advisory Committee regulates student computer fees. Procedures consistent with the MTU computing strategy will be used to maintain our upgraded computer laboratory.

## **D. Library Resources**

MTU's library has a large collection of books, periodicals and on-line services that enable scholarship in applied ecology and environmental sciences. However, when the number of students in the program exceeds 50, additional funds should be added to the library's base budget to support the acquisition of new periodicals and on-line services.

## **IX. Appendices**

Appendices A-C are available for review in the Senate Office.

**Adopted by Senate: November 6, 1996**

**Approved by President: November 7, 1996**

**Approved by Board of Control: May 23, 1997**