School of Forest Resources And Environmental Science

CURRICULUM GUIDE

2009-2010

SCHOOL OF FOREST RESOURCES & ENVIRONMENTAL SCIENCE

We prepare students to create the future!

Our Degree Programs

The following undergraduate degrees, certificates and minors are available from the School of Forest Resources and Environmental Science or in cooperation with other departments on campus:

Undergraduate Degrees

B.S. in Forestry
B.S. in Wildlife Ecology and Management
B.S. in Applied Ecology and Environmental Sciences
With Directed Electives in: Plant Ecology and Wetlands
Communicating Natural Resources

Graduate Degrees

Master of Science in Forestry
Master of Science in Applied Ecology
Master of Science in Forest Ecology and Management
Master of Science in Forest Molecular Genetics and Biotechnology
Master of Forestry
Ph.D. in Forest Science
Ph.D. in Forest Molecular Genetics and Biotechnology

Secondary School Teacher Certification in Biology

B.S. in Applied Ecology and Environmental Sciences with directed electives
B.S. in Forestry with directed electives
B.S. in Wildlife Ecology and Management with directed electives

Certificates

Certificate in Industrial Forestry

Minors offered within the School of Forest Resources and Environmental Science

Ecology
Plant Sciences
Plant Biotechnology
Remote Sensing

WHAT, WHO AND WHERE

What……	Who……	Where…..		
Advising:				
Academic	Mary Jurgensen	110	487-2953	thefinn@mtu.edu
Career	All faculty and the Career Center			
Building Access/Keys	Sherry Sandretto	131	487-1951	slsandre@mtu.edu
Certificate in Industrial Forestry	Blair Orr	145A	487-2291	bdorr@mtu.edu
Copying accounts	Maggie Mleko	127	487-2454	mmmleko@mtu.edu
Graduate Program	Chandrashekhar Joshi	167	487-3480	cpjoshi@mtu.edu
Learning Centers:				
Biology - DOW Bldg.		744	487-2025	
Math - Fisher Hall		128	487-2184	
Writing - Walker		107	487-2007	
Minors	Mary Jurgensen	110	487-2953	thefinn@mtu.edu
National Student Exchange	Mary Jurgensen	110	487-2953	thefinn@mtu.edu
Peace Corps	Blair Orr	145A	487-2953	bdorr@mtu.edu
Study Abroad	Mary Jurgensen	110	487-2953	thefinn@mtu.edu
Teaching Certificate	Mary Jurgensen	110	487-2953	thefinn@mtu.edu
Travel Reimbursements	Andrea Longhini	123	487-3603	aelonghi@mtu.edu
Tutoring	Mary Jurgensen	110	487-2953	thefinn@mtu.edu
Working/Payroll	Karin Chapin	129	487-3437	klchapin@mtu.edu

FORESTRY

For students in the undergraduate **FORESTRY** major, an education will specifically include:

1.) An understanding of the structure and functions of forest ecosystems, with emphasis on natural processes critical to their long-term health and productivity;

2.) Knowledge of techniques that can be applied to generate management options for forested landscapes;

3.) The ability to use this understanding and knowledge to develop and communicate realistic alternatives for managing forested landscapes; and

4.) Together with other professionals and the concerned public, the ability to implement decisions in such a way as to meet the needs of society while maintaining the integrity of ecosystems.

Career opportunities exist for forester in public agencies and in private industry.

Our B.S. in Forestry is accredited by the Society of American Foresters, and graduates meet general qualifications for forester positions. Private industry positions exist in consulting and forest management. Our graduates are employed as foresters, district conservationists, soil conservation technicians, forest inventory specialists, assistant ecologists and park rangers.

Forestry

1. Major Requirements		Credits	Prerequisites
FW1035	Wood Anatomy and Properties (s)*	4	
FW1050	Natural Resources Seminar (s)	1	
FW2010	Vegetation of North America(f)	4	
FW2051	Field Techniques (f)	1	
FW3010	Practice of Silviculture (f)	4	FW2010 & FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3150	Timber Harvesting (f)	2	FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3190	Multi-resource Assessment (f)	3	FW2051 & FW3020 & MA27020
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 and MA2720
FW3330	Soil Science (f)	4	CH1150 & CH1151 (pre or coreq)
FW3540	Intro. to GIS for Natural Resource Mgt. (s)	4	MA2720 (pre or coreq)
FW3600	Wildlife Habitat (f)	3	sophomore standing
FW3840	Forest Health (f)	3	FW3020
FW4080	Forest Economics and Finance (s)	3	sophomore standing
FW4120	Tree Physiology and Genetics (s)	3	
FW4140	Ecosystem Modeling (s)	2	FW3010 or FW3012
FW4150	Forest Resource Management (f)	3	FW3010 & FW4080
FW4370	Forest and Landscape Hydrology (s)	3	
FW4810	Integrated Resource Assessment (f)	4	FW3020, FW3540 & (FW3190 or FW3410)
		59	

2. Cognate Course Requirements			
EC3400	Economic Decision Analysis (f,s,su)	3-4	UN2002
Or	BA3620 Project Management (f,s,su)		MA2720
Or	BA3580 Legal Environment of Business (f,s,su)		junior standing
Or	AF3001 (f,s)		
Or	AR2001 & AR2011 & AR2002 & AR2012		
BL2160	Botany (s)	4	
MA1135	Calculus for Life Sciences (f,s,su)	4	MA1031 or MA1032
MA2720	Statistical Methods (f,s,su)	4	MA1031 or MA1032
CH1150	University Chemistry I (f,s,su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
		19-20	

3. General Education Requirements			
UN1001	Perspectives on Inquiry (f,s)	3	freshmen only
UN1002	World Cultures (f,s,su)	4	freshmen only
UN2001	Revisions (f,s)	3	UN1001 & (UN1002 or UN1003)
UN2002	Institutions (f,s)	3	sophomores only
HASS Distribution electives		12	
FW3110	Natural Resource Policy (s)	3	
		28	

4. Free Electives	**21-22**
Total Credits Required for Graduation	**128**

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.

*denotes semester offered f= fall, s= spring, su= summer

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FORESTRY

First Year		Second Year		Third Year		Fourth Year	
UN1001 (3) Perspectives on Inquiry	UN1002 (4) World Cultures	UN2001 (3) Revisions	UN2002 (3) Institutions	**FALL CAMP** FW3010 (4) Practice of Silv. FW3840 (3) Forest Health FW3600 (3) Wildlife Habitat FW3170 (1) LM-GPS FW3190 (3) Multiresource Assess. FW3150 (2) Timber Harvesting	FW4080 (3) For. Econ. & Finance	FW4810 (4) Integ. Res Assess.	Elective (13)
FW2051 (1) Field Techniques	BL2160 (4) Botany	**MA2720 (4) Statistical Methods**	FW1035 (4) Wood Anat. and Proper.		FW4120 (3) Tree Phys. & Genetics	HASS Distribution (3)	EC3400 (3) Economic Decision Analysis or BA3580 (3) Legal Environ. of Business or BA3620 (3) Project Management
FW2010 (4) Vegetation of N. America	CH1150 (3) University Chemistry I	**FW3020 (3) Forest Ecology**	**FW3200 (4) Inventory Mon. & Anl.**		FW3110 (3) Nat. Res. Policy	FW4150 (3) Forest Res. Mgmt.	
MA1135 (4) Calculus for Life Sciences	CH1151 (1) University Chem Lab I	FW3330 (4) Soil Science	**FW3540 (4) Intro to GIS**		FW4140 (2) Vegetation Modeling	Elective (6)	
HASS Distribution (3)	FW1050 (1) Nat. Res. Seminar	HASS Distribution (3)			FW4370 (3) Forest and Land. Hydro.		
	Elective (3)				HASS Distribution (3)		
15 credits	16 credits	17 credits	15 credits	16 credits	17 credits	16 credits	16 credits

Courses in bold are required for Fall Camp.

APPLIED ECOLOGY & ENVIRONMENTAL SCIENCES

The broad purpose of the **APPLIED ECOLOGY AND ENVIRONMENTAL SCIENCES** undergraduate degree program is to equip students with the knowledge, expertise, ethics, and perspective necessary for the resolution of contemporary environmental problems. Our graduates will be challenged to protect the integrity of ecosystems and ensure the sustainability of natural resources while solving problems posed by growth of the human enterprise.

For students in the applied ecology and environmental sciences major, this specifically includes:

1.) A diverse and highly technical background in applied ecology and environmental sciences;

2.) Ability to assess the environmental conditions of both terrestrial and aquatic ecosystems;

3.) Ability to make land-use decisions that integrate utilization with the maintenance and protection of ecosystem composition, structure and function;

4.) Acquire the communication skills and professional ethics necessary to work with their peers and other individuals to solve ecological and environmental problems.

This degree program is intended to meet the demand for broadly-educated ecologists and environmental scientists to cope with increasingly complex environmental problems. 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 multi-disciplinary preparation will provide students with strong employment potential in a variety of ecological and environmental fields.

In this degree program, students are directed to take electives in one of two topic areas: Plant Ecology and Wetlands; or Communicating Natural Resources.

Applied Ecology and Environmental Sciences

1. Major Requirements		Credits	Prerequisites
FW1050	Natural Resources Seminar (s)*	1	
FW2010	Vegetation of North America (f)	4	
FW2051	Field Techniques (f)	1	
FW3012	Survey of Silviculture (f)	1	FW2010 & FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3180	Geomorphology, Landscapes & Ecosystems (f)	2	
FW3190	Multi-resource Assessment (f)	3	FW2051 & FW3020 & MA2720
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 and MA2720
FW3330	Soil Science (f)	4	CH1150 & CH1151 (pre or coreq)
FW3410	Conservation Biology (s)	3	
FW3540	Intro. To GIS for Natural Resource Mgt. (s)	4	MA2720 (pre or coreq)
FW3630	Wildlife Habitat Diseases & Parasites (f)	4	sophomore standing
FW3800	Insect Ecology (f)	2	
FW3840	Forest Health (f)	3	FW3020
FW4810	Integrated Resource Assessment (f)	4	FW3540 & FW3020 & (FW3190 or FW3410)
		44	

2. Directed Electives (1 group required) **17-18**

These electives are directed at advanced study in a particular topic area.

Plant Ecology and Wetlands

BL3400	Principles of Ecology (f)	4	BL1020 or BL1040
BL2160	Botany (s)	4	
FW3075	Plant Biotechnology (s)	3	
FW4220	Wetlands (f)	4	
FW4120	Tree Physiology (s)	3	

Communicating Natural Resources

ED3510	Communicating Science I (f s,su)	2	UN2002
BA2330	Accounting I (f,s,su)	3	sophomore standing
BA2700	Business Problem Solving (f,s,su)	3	sophomore standing
FW3760	Human Dimensions of Nat. Res. (f)	3	
HU3120	Tech. & Scientific Communication (f,s,su)	3	UN1002 or UN1003 & junior standing
HU3629	Spec. Topics in Professional Writing (s)	OR	UN1002 or UN1003
HU4625	Risk Communication (s,su)	OR	UN2002 & junior standing
HU4628	Usability & Instructions Writing (s – alt. yrs)	OR	HU3120
HU3871	Media & Communication Theory (f)	3	UN1002 or UN1003

3. Cognate Course Requirements

BL1040	Principles of Biology (f)	4	
MA1135	Calculus for Life Sciences (f,s,su)	4	MA1031 or MA1032
MA2720	Statistical Methods (f,s,su)	4	MA1031 or MA1032
CH1150	University Chemistry I (f,s,su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
		16	

4. General Education Requirements

UN1001	Perspectives on Inquiry (f,s,su)	3	freshmen only
UN1002	World Cultures (f,s,su)	4	freshmen only
UN2001	Revisions (f,s,su)	3	UN1001 & (UN1002 or UN1003)
UN2002	Institutions (f,s,su)	3	sophomores only
HASS Distribution electives		12	
FW3110	Natural Resource Policy (s)	3	
		28	

5. Free Electives	**22-23**
Total Credits Required for Graduation	**128**

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.

*denotes semester offered f= fall, s= spring, su= summer

AEES ----- Plant Ecology and Wetlands

First Year		Second Year		Third Year		Fourth Year	
UN1001 (3) Perspectives on Inquiry	UN1002 (4) World Cultures	UN2001 (3) Revisions	UN2002 (3) Institutions	**FALL CAMP**	FW4120 (3) Tree Phys. & Genetics	FW4810 (4) Integ. Res Assess.	Elective (12)
FW2051 (1) Field Techniques	BL2160 (4) Botany	**FW3020 (3) Forest Ecology**	FW3075 (3) Plant Biotech	FW3012 (1) Survey of Silviculture.	HASS Distribution (6)	FW4220 (4) Wetlands	HASS Distribution (3)
FW2010 (4) Vegetation of N. America	CH1150 (3) University Chemistry I	FW3330 (4) Soil Science	FW3110 (3) Nat. Res. Policy	FW3840 (3) Forest Health	FW3410 (3) Conserv. Biology	Elective (4)	
BL1040 (4) Principles of Biology	CH1151 (1) University Chem Lab I	**MA2720 (4) Statistical Methods**	**FW3540 (4) Intro. To GIS**	FW3630 (4) Wildlife Habitat. Dis & Paras.	Elective (4)	BL3400 (4) Principles of Ecology	
HASS Distribution (3)	FW1050 (1) Nat. Res. Seminar	Elective (3)	**FW3200 (4) Inventory, Monit. & Analy.**	FW3170 (1) LM-GPS			
	MA1135 (4) Calculus for Life Sciences			FW3190 (3) Multiresource Assessment..			
				FW3800 (2) Insect Ecology			
				FW3180 (2) Geomorphology & Vegetation			
15 credits	17 credits	17 credits	17 credits	16 credits	15 credits	16 credits	15 credits

Courses in bold are required for Fall Camp

AEES --- Communicating Natural Resources

First Year		Second Year		Third Year	Fourth Year		
UN1001 (3) Perspectives on Inquiry	UN1002 (4) World Cultures	UN2001 (3) Revisions	UN2002 (3) Institutions	**FALL CAMP** FW3012 (1) Survey of Silviculture FW3840 (3) Forest Health FW3630 (4) Wildlife Habitat Dis. & Paras. FW3170 (1) LM-GPS FW3190 (3) Multiresource Assessment. FW3800 (2) Insect Ecology FW3180 (2) Geomorphology & Vegetation	HU3120 (3) Tech. and Sci. Comm.	FW4810 (4) Integ. Resour. Assessment	Elective (14)
FW2051 (1) Field Techniques	ED3510 (2) Communic. Science I	**FW3020 (3) Forest Ecology.**	HASS Distribution (3)		Elective (6)	FW3760 (3) Human Dimen. Nat. Res.	HU4625 (3) Risk Communic. or HU3629 (3) Professional Writing or HU4628 (3) Usability & Inst. Wrtg. or HU3871 (3) Media & Comm. Theory
FW2010 (4) Vegetation of N. America	CH1150 (3) University Chemistry I	FW3330 (4) Soil Science	FW3110 (3) Nat. Res. Policy		BA2330 (3) Accounting I	HASS Distribution (6)	
BL1040 (4) Principles of Biology	CH1151 (1) University Chem Lab I	**MA2720 (4) Statistical Methods**	**FW3540 (4) Intro. To GIS**		FW3410 (3) Conserv. Biology	BA2700 (3) Business Problem Solving	
HASS Distribution (3)	FW1050 (1) Nat. Res. Seminar	Elective (3)	**FW3200 (4) Inventory Monit. & Alys.**				
	MA1135 (4) Calculus for Life Sciences						
15 credits	15 credits	17 credits	17 credits	16 credits	15 credits	16 credits	17 credits

Courses in bold are required for Fall Camp.

WILDLIFE ECOLOGY AND MANAGEMENT

The School of Forest Resources and Environmental Science's **WILDLIFE ECOLOGY AND MANAGEMENT** degree trains both undergraduate and graduate students in ecosystem management, wildlife ecology and management, and forest ecology. The goals of this curriculum are to train students who:

1.) Have a diverse hands-on technical background in wildlife ecology and management;

2.) Are able to assess the environmental conditions of both terrestrial and aquatic ecosystems;

3.) Can make land-use decisions that integrate utilization for wildlife with the maintenance and protection of ecosystem composition, structure and function;

4.) Have the necessary knowledge and skills in the areas of humanities, social sciences, political sciences and communication, and professional ethics necessary to work with their peers and other individuals to manage wildlife populations.

Our B.S. in Wildlife Ecology and Management will prepare students for a variety of career options. Students may find employment in the private sector as managers of wildlife oriented lands and additional opportunities will be found in state and federal agencies. Other students will pursue this degree program because it is what interests them, and use it as a more broadly defined qualification as they enter the job and career market.

This degree emphasizes wildlife ecology in the context of land management decisions.

Wildlife Ecology and Management

1. Major Requirements		Credits	Prerequisites
FW1050	Natural Resources Seminar (s)*	1	
FW2010	Vegetation of North America (f)	4	
FW2051	Field Techniques (f)	1	
FW3012	Survey of Silviculture (f)	1	FW2010 & FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3180	Geomorphology, Landscapes & Ecosystems (f)	2	
FW3190	Multi-Resource Assessment (f)	3	FW3020 & MA2720
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 & MA2720
FW3410	Conservation Biology (s)	3	
FW3540	Intro. to GIS for Natural Resource Mgt. (s)	4	MA2720 (pre or coreq)
FW3630	Wildlife Habitat Diseases & Parasites (f)	4	
FW3800	Insect Ecology (f)	2	
FW3840	Forest Health (f)	3	FW3020
FW4260	Population Ecology (f)	3	
FW4610	Wildlife Ecology (f)	3	FW3020 or BL3400
FW4810	Integrated Resource Assessment (f)	4	FW3540 & FW3020 & (FW3190 or FW3410)
3 of the 4 following classes:			
FW3610	Ornithology (s)	4	BL1040 or BL1020
FW4240	Mammalogy (f)	4	BL1040 & junior standing
FW4620	Herpetology (s – alt. yrs)	3	BL1040 or BL1020
BL4440	Fish Biology (s – alt. yrs)	4	BL1040 or BL1020
		57-58	

2. Cognate Course Requirements			
BL1040	Principles of Biology (f)	4	
BL2170	Zoology (f)	4	BL1040 or BL1020
MA1135	Calculus for Life Sciences (f,s,su)	4	MA1031 or MA1032
MA2720	Statistical Methods (f, s,su)	4	MA1031 or MA1032
CH1150	University Chemistry I (f,s,su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
		20	

3. General Education Requirements			
UN1001	Perspectives on Inquiry (f,s)	3	freshmen only
UN1002	World Cultures (s)	4	freshmen only
UN2001	Revisions (f,s)	3	UN1001 & UN1002
UN2002	Institutions (f,s)	3	sophomores only
HASS Distribution electives		12	
FW3110	Natural Resource Policy (s)	3	
		28	

4. Free Electives	**22-23**	
Total Credits Required for Graduation	**128**	

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.

*denotes semester offered f= fall, s= spring, su= summer

Wildlife Ecology and Management

First Year		Second Year		Third Year		Fourth Year	
UN1001 (3) Perspectives on Inquiry	UN1002 (4) World Cultures	UN2001 (3) Revisions	UN2002 (3) Institutions	**FALL CAMP** FW3012 (1) Survey of Silviculture. FW3840 (3) Forest Health FW3630 (4) Wildlife Habitat Dis. & Paras. FW3170 (1) LM-GPS FW3190 (3) Multiresource Assessment FW3800 (2) Insect Ecology FW3180 (2) Geomorphology & Vegetation	FW3410 (3) Conserv. Biology	FW4810 (4) Integ. Resour. Assessment	Elective (9)
FW2051 (1) Field Techniques	HASS Distribution (3)	**FW3020 (3) Forest Ecology**	HASS Distribution (3)		Elective (6)	*FW4240 (4) Mammalogy or Elective	HASS Distribution (3)
FW2010 (4) Vegetation of N. America	CH1150 (3) University Chemistry I	**MA2720 (4) Statistical Methods**	FW3110 (3) Nat. Res. Policy		*FW3610 (4) Ornithology or elective	FW4260 (4) Population Ecology	*FW4620 (3) Herpetology or elective
BL1040 (4) Principles of Biology	CH1151 (1) University Chem Lab I	BL2170 (4) Zoology	**FW3540 (4) Intro. to GIS**		*BL4440 (4) Fish Biology or elective	FW4610 (3) Wildlife Ecology	
HASS Distribution (3)	FW1050 (1) Nat. Res. Seminar	Elective (3)	**FW3200 (4) Inventory, Monit. & Analy.**				
	MA1135 (4) Calculus for Life Sciences						
15 credits	16 credits	17 credits	17 credits	16 credits	17 credits	15 credits	15 credits

Double Major -- Forestry and Wildlife Ecology

1. Major	Requirements	Credits	Prerequisites
FW1035	Wood Anatomy and Properties (s)*	4	
FW1050	Natural Resources Seminar (s)	1	
FW2010	Vegetation of North America (f)	4	
FW2051	Field Techniques (f)	1	
FW3010	Practice of Silviculture (f)	4	FW2010 & FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3150	Timber Harvesting (f)	2	FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3190	Multi-Resource Assessment (f)	3	FW2051 & FW3020 & MA27020
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 & MA2720
FW3330	Soil Science (f)	4	CH1150 & CH1151 (pre or coreq)
FW3410	Conservation Biology (s)	3	
FW3540	Intro. to GIS for Natural Resource Mgt. (s)	4	MA2720 (pre or coreq)
FW3600	Wildlife Habitat (f)	3	sophomore standing
FW3840	Forest Health (f)	3	FW3020
FW4080	Forest Economics and Finance (s)	3	sophomore standing
FW4120	Tree Physiology and Genetics (s)	3	
FW4140	Ecosystem Modeling (s)	2	FW3010 or FW3012
FW4150	Forest Resource Management (f)	3	FW3010 & FW4080
FW4260	Population Ecology (f)	3	
FW4370	Forest & Landscape Hydrology (s)	3	
FW4610	Wildlife Ecology (f)	3	FW3020 or BL3400
FW4810	Integrated Resource Assessment (f)	4	FW3020 & FW3540 & (FW3190 or FW3410)
3 of the 4 following classes:			
FW3610	Ornithology (s)	4	BL1040 or BL1020
FW4240	Mammalogy (f)	4	BL1040 & junior standing
FW4620	Herpetology (s – alt. yrs)	3	BL1040 or BL1020
BL4440	Fish Biology (s – alt. yrs)	4	BL1040 or BL1020
		79-80	

2. Cognate Course Requirements			
EC3400	Economic Decision Analysis (f,s,su)	3	UN2002
Or	BA3620 Project Management (f,s,su)		MA2720
Or	BA3580 Legal Environment of Business (f,s,su)		junior standing
Or	AF3001 (f,s)		
Or	AR2001 & AR2011 & AR2002 & AR2012		
BL1040	Principles of Biology (f,su)	4	
BL2160	Botany (s)	4	
BL2170	Zoology (f)	4	BL1040 or BL1020
MA1135	Calculus for Life Sciences (f,s)	4	MA1031 or MA1032
MA2720	Statistical Methods (f,s,su)	4	MA1031 or MA1032
CH1150	University Chemistry I (f,s,su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
2 of the following classes:			
BL2200	Genetics (s)	3	BL1040 or BL1020 & BL2100
BL2100	Principles of Biochemistry (f,su)	3	BL1040 or BL1020 & CH1150 & CH1151
BL3190	Evolution (s)	3	BL1040 or BL1020
BL2010	Anatomy and Physiology I (f)	3	CH1150 and CH1151
GE2000	Understanding the Earth (f,su)	3	
GE2100	Environmental Geology (s)	3	
4th class of the 3 of 4 FW/BL classes listed under **Major Requirements** above		3-4	
		33-34	

3. General Education Credits

UN1001	Perspectives on Inquiry (f,s)	3	freshmen only
UN1002	World Cultures (s)	4	freshmen only
UN2001	Revisions (f,s)	3	UN1001 & UN1002
UN2002	Institutions (f,s)	3	sophomores only
HASS Distribution electives		12	
FW3110	Natural Resource Policy (s)	3	
		28	

Total Credits Required for Double Major **140-142**

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.
*denotes semester offered f= fall, s= spring, su= summer

Double Major -- Forestry and Applied Ecology

1. Major Requirements		Credits	Prerequisites
FW1035	Wood Anatomy and Properties (s)*	4	
FW1050	Natural Resources Seminar (s)	1	
FW2010	Vegetation of North America(f)	4	
FW2051	Field Techniques (f)	1	
FW3010	Practice of Silviculture (f)	4	FW2010 & FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3150	Timber Harvesting (f)	2	FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3190	Multi-resource Assessment (f)	3	FW2051 & FW3020 & MA2720
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 & MA2720
FW3330	Soil Science (f)	4	CH1150 & CH1151 (pre or coreq)
FW3410	Conservation Biology (s)	3	
FW3540	Intro. to GIS for Natural Resource Mgt. (s)	4	MA2720 (pre or coreq)
FW3600	Wildlife Habitat (f)	3	sophomore standing
FW3840	Forest Health (f)	3	FW3020
FW4080	Forest Economics and Finance (s)	3	sophomore standing
FW4120	Tree Physiology and Genetics (s)	3	
FW4140	Ecosystem Modeling (s)	2	FW3010 or FW3012
FW4150	Forest Resource Management (f)	3	FW3010 & FW4080
FW4370	Forest & Landscape Hydrology (s)	3	
FW4810	Integrated Resource Assessment (f)	4	FW3020 & FW3540 & (FW3190 or FW3410)
		65	

2. Cognate Course Requirements			
EC3400	Economic Decision Analysis (f,s,su)	3	UN2002
Or	BA3620 Project Management (f,s,su)		MA2720
Or	BA3580 Legal Environment of Business (f,s,su)		junior standing
Or	AF3001 (f, s)		
Or	AR2001 & AR2011 & AR2002 & AR2012		
BL1040	Principles of Biology (f,su)	4	
BL2160	Botany (s)	4	
MA1135	Calculus for Life Sciences (f,s)	4	MA1031 or MA1032
MA2720	Statistical Methods (f,s,su)	4	MA1031 or MA1032
CH1150	University Chemistry (f,s,su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
2 of the following classes:			
BL2200	Genetics (s)	3	BL1040 or BL1020 & BL2100
BL2100	Principles of Biochemistry (f,su)	3	BL1040 or BL1020 & CH1150 & CH1151
BL3190	Evolution (s)	3	BL1040 or BL1020
BL2010	Anatomy and Physiology I (f)	3	CH1150 and CH1151
GE2000	Understanding the Earth (f,su)	3	
GE2100	Environmental Geology (s)	3	
		29	

2. Directed Electives (1 group required) **17-18**

These electives are directed at advanced study in a particular topic area.

Plant Ecology and Wetlands

BL3400	Principles of Ecology (f)	4	BL1040 or BL1020
**BL2160	Botany (s)	4	
FW3075	Plant Biotechnology (s)	3	
FW4220	Wetlands (f)	4	
**FW4120	Tree Physiology & Genetics(s)	3	

Communicating Natural Resources

ED3510	Communicating Science (f,s,su)	2	UN2002
BA2330	Accounting I (f,s,su)	3	sophomore standing
BA2700	Business Problem Solving (f,s,su)	3	sophomore standing
FW3760	Human Dimensions of Nat. Res. (f)	3	

HU3120	Tech. & Scientific Communication (f,s)	3	UN1002 & junior standing
HU3629	Spec. Topics in Professional Writing (s)	OR	UN1002 or UN1003
HU4625	Risk Communication (s)	OR	UN2002 & junior standing
HU4628	Usability & Instructions Writing (s – alt. yrs.)	OR	HU3120
HU3871	Comm. Technologies & Culture (f)	3	

3. General Education Requirements

UN1001	Perspectives on Inquiry (f,s)	3	freshmen only
UN1002	World Cultures (s)	4	freshmen only
UN2001	Revisions (f,s)	3	UN1001 & UN1002
UN2002	Institutions (f,s)	3	sophomores only
HASS Distribution electives		12	
FW3110	Natural Resource Policy (s)	3	
		28	

Total Credits Required for Double Major **131-137**

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.
*denotes semester offered f= fall, s= spring, su= summer
**Required in the Forestry core

Double Major:
Wildlife Ecology and Management &
Applied Ecology and Environmental Sciences

1. Major Requirements		**Credits**	**Prerequisites**
FW1050	Natural Resources Seminar (s)*	1	
FW2010	Vegetation of North America (f)	4	
FW2051	Field Techniques (f)	1	
FW3012	Survey of Silviculture (f)	1	FW2010 &FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3180	Geomorphology, Landscapes & Ecosystems (f)	2	
FW3190	Multi-Resource Assessment (f)	3	FW2051 & FW3020 & MA2720
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 and MA2720
FW3330	Soil Science (f)	4	CH1150 & CH1151 (pre or coreq)
FW3410	Conservation Biology (s)	3	
FW3540	Intro. To GIS for Natural Resource Mgt. (s)	4	MA2720 (pre or coreq)
FW3630	Wildlife Habitat Diseases & Parasites (f)	4	sophomore standing
FW3800	Insect Ecology (f)	2	
FW3840	Forest Health (f)	3	FW3020
FW4260	Population Ecology (f)	3	
FW4610	Wildlife Ecology (f)	3	FW3020 or BL3400
FW4810	Integrated Resource Assessment (f)	4	FW3540 & FW3020 & (FW3190 or FW3410)
3 of the 4 following classes:			
FW3610	Ornithology (s)	4	BL1040 or BL1020
FW4240	Mammalogy (f)	4	BL1040 & junior standing
FW4620	Herpetology (s - alt. yrs)	3	BL1040 or BL1020
BL4440	Fish Biology (s - alt. yrs)	4	BL1040 or BL1020
		44	

2. Directed Electives (1 group required) **17-18**

These electives are directed at advanced study in a particular topic area.

Plant Ecology and Wetlands			
BL3400	Principles of Ecology (f)	4	BL1020 or BL1040
BL2160	Botany (s)	4	
FW3075	Plant Biotechnology (s)	3	
FW4220	Wetlands (f)	4	
FW4120	Tree Physiology (s)	3	

Communicating Natural Resources			
ED3510	Communicating Science I (f,s,su)	2	UN2002
BA2330	Accounting I (f,s,su)	3	sophomore standing
BA2700	Business Problem Solving (f,s,su)	3	sophomore standing
FW3760	Human Dimensions of Nat. Res. (f)	3	
HU3120	Tech. & Scientific Communication (f,s,su)	3	UN1002 & junior standing
HU3629	Spec. Topics in Professional Writing (s)	OR	UN1002 or UN1003
HU4625	Risk Communication (s,su)	OR	UN2002 & junior standing
HU4628	Usability & Instructions Writing (s – alt. yrs)	OR	HU3120
HU3871	Media & Communication Theory (f)	3	

3. Cognate Course Requirements

BL1040	Principles of Biology (f)	4	
BL2170	Zoology (f)	4	BL1040 or BL1020
MA1135	Calculus for Life Sciences (f,s)	4	MA1031 or MA1032
MA2720	Statistical Methods (f,s,su)	4	MA1031 or MA1032
CH1150	University Chemistry I (f,s,su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
		16	

4. General Education Requirements

UN1001	Perspectives on Inquiry (f,s,su)	3	freshmen only
UN1002	World Cultures (f,s,su)	4	freshmen only
UN2001	Revisions (f,s,su)	3	UN1001 & UN1002
UN2002	Institutions (f,s,su)	3	UN1001 & UN1002
HASS Distribution electives		12	
FW3110	Natural Resource Policy (s)	3	

5. Free Electives	**22-23**
Total Credits Required for Graduation	**128**

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.

*denotes semester offered f= fall, s= spring, su= summer

SECONDARY EDUCATION CERTIFICATION in BIOLOGY

Students can obtain a secondary teaching endorsement in biology with either the B.S. in Forestry, the B.S. in Applied Ecology and Environmental Sciences, or the B.S. in Wildlife Ecology and Management. This endorsement qualifies the person for teaching high school biology.

Students interested in this degree program should meet with the advisor in the Michigan Tech Department of Education and the advisor in the School of Forest Resources and Environmental Science for details.

B.S. in Forestry
with Secondary Education Option in Biology

1. Major Requirements		Credits	Prerequisites
FW1035	Wood Anatomy and Properties (s)*	4	
FW1050	Natural Resources Seminar (s)	1	
FW2010	Vegetation of North America (f)	4	
FW2051	Measuring Forest Resources (f)	1	
FW3010	Practice of Silviculture (f)	4	FW2010 & FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3150	Timber Harvesting (f)	2	FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3190	Multi-Resource Assessment (f)	3	FW2051 & FW3020 & MA2720
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 and MA2720
FW3330	Soil Science (f)	4	CH1150 & CH1151 (pre or coreq)
FW3410	Conservation Biology (s)	3	
FW3540	Intro. to GIS for Natural Resource Mgmt. (s)	4	MA2720 (pre or coreq)
FW3600	Wildlife Habitat (f)	3	sophomore standing
FW3840	Forest Health (f)	3	FW3020
FW4080	Forest Economics and Finance (s)	3	sophomore standing
FW4120	Tree Physiology and Genetics (s)	3	
FW4140	Ecosystem Modeling (s)	2	FW3010 or FW3012
FW4150	Forest Resource Management (f)	3	FW3010 & FW4080
FW4370	Forest & Landscape Hydrology (s)	3	
FW4810	Integrated Resource Assessment (f)	4	FW3020 & FW3540 & (FW3190 or FW3410)
		62	

2. Cognate Course Requirements			
EC3400	Economic Decision Analysis (f,s,su)	3	UN2002
Or	BA3620 Project Management (f,s,su)		MA2720
Or	BA3580 Legal Environment of Business (f,s,su)		junior standing
Or	AF3001 (f, s)		
Or	AR2001 & AR2011 & AR2002 & AR2012		
BL1040	Principles of Biology (f)	4	
BL2100	Principles of Biochemistry (f)	3	(BL1040 or BL1020) & (CH1150 & CH1151)
BL2160	Botany(s)	4	
BL2170	Zoology (f)	4	BL1020 or BL1040
BL2200	Genetics (s)	3	BL1020 or BL1040 & BL2100
MA1135	Calculus for Life Sciences (f,s,su)	4	MA1031 or MA1032
MA2720	Statistical Methods (f,s,su)	4	MA1031 or MA1032
CH1150	University Chemistry I (f,s,su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
		33	

3. General Education Requirements			
UN1001	Perspectives on Inquiry (f,s)	3	freshmen only
UN1002	World Cultures (s)	4	freshmen only
UN2001	Revisions (f,s)	3	UN1001 & UN1002
UN2002	Institutions (f,s)	3	sophomores only
HASS Distribution electives**		12	
FW3110	Natural Resource Policy (s)	3	
		28	

4. Department of Education Requirements			
ED3100	Instructional Technology (f,s)	2	
ED3110	Psych. Foundations of Education (f,s)	3	PSY2000 &UN2002
ED3210	Foundations of Education (f,s)	2	UN1002, (ED3110 & ED3410 coreq)
ED3410	Clinical experience (f,s)	1	junior standing

ED4700	Fundamentals of Instruction (f,s)	3	ED3110, ED3210, & ED3410
ED4710	Methods of Teaching Science & Math (f,s)	3	ED4700 (coreq)
ED4910	Directed Teaching (f,s)	12	ED3100, ED4700 & (ED4710 coreq)
HU4150	Literacy in the Content Areas (f,s)	4	ED3110 (pre or coreq)
		30	

Also required is EH3985 First Aid/CPR or Certification in CPR and First Aid by the American Heart Association or the American Red Cross

Highly recommended: (credits not included in total)

ENG3000	Engineering for Non-Believers	3	MA1135 & PH1110

5. Teacher Certification Minor **19-26**

Total credits required dependent on teacher certification minor chosen and any double listing of HASS distribution courses with Dept. of Education core courses.

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.

*denotes semester offered f= fall, s= spring, su= summer
**Some distribution requirements may be met by courses required by the Dept. of Education and the teacher certification minor. See School of Forest Resources & Environmental Science advisor for details.

B.S. in Applied Ecology and Environmental Science with Secondary Education Option in Biology

1. Major Requirements		Credits	Prerequisites
FW1050	Natural Resources Seminar (s)	1	
FW2010	Vegetation of North America (f)	4	
FW2051	Field Techniques (f)	1	
FW3012	Survey of Silviculture (f)	1	FW2010 & FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3180	Geomorphology, Landscapes & Ecosystems (f)	2	
FW3190	Multi-Resource Assessment (f)	3	FW2051 & FW3020 & MA27020
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 and MA2720
FW3330	Soil Science (f)	4	CH1150 & CH1151 (pre or coreq)
FW3410	Conservation Biology (s)	3	
FW3540	Intro. to GIS for Natural Resource Mgmt. (s)	4	MA2720 (pre or coreq)
FW3630	Wildlife Habitat, Diseases & Parasites (f)	4	sophomore standing
FW3800	Insect Ecology (f)	2	
FW3840	Forest Health (f)	3	FW3020
FW4810	Integrated Resource Assessment (f)	4	FW3540 & FW3020 & (FW3190 or FW3410)
		44	

2. Cognate Course Requirements			
BL1040	Principles of Biology (f)	4	
BL2100	Principles of Biochemistry (f)	3	BL1040 or BL1020 & CH1150 & CH1151
BL2160	Botany(s)	4	
BL2170	Zoology (f)	4	BL1020 or BL1040
BL2200	Genetics (s)	3	BL1020 or BL1040 & BL2100
BL3190	Evolution (s)	3	BL1020 or BL1040
MA1135	Calculus for Life Sciences (f, s, su)	4	MA1031 or MA1032
MA2720	Statistical Methods (f, s, su)	4	MA1031 or MA1032
CH1150	University Chemistry I (f, s, su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
		33	

3. Directed Electives (1 group required) **17-18**

Plant Ecology and Wetlands

BL3400	Principles of Ecology (f)	4	BL1020 or BL1040
BL2160	Botany (s)	4	
FW3075	Plant Biotechnology (s)	3	
FW4220	Wetlands (f)	4	
FW4120	Tree Physiology (s)	3	

Communicating Natural Resources

ED3510	Communicating Science (f, s)	2	UN2002
BA2330	Accounting I (f, s, su)	3	sophomore standing
BA2700	Business Problem Solving (f, s, su)	3	sophomore standing
FW3760	Human Dimensions of Nat. Res. (f)	3	
HU3120	Tech. & Scientific Communication (f, s)	3	UN1002 & junior standing
HU3629	Spec. Topics in Professional Writing (s)	OR	UN1002 or UN1003
HU4625	Risk Communication (s)	OR	UN2002 & junior standing
HU4628	Usability & Instructions Writing (s)	OR	HU3120
HU3871	Media & Communication Theory (f)	3	

4. General Education Requirements

UN1001	Perspectives on Inquiry (f, s)	3	freshmen only
UN1002	World Cultures (s)	4	freshmen only
UN2001	Revisions (f, s)	3	UN1001 & UN1002
UN2002	Institutions (f, s)	3	UN1001 & UN1002
HASS Distribution electives**		12	
FW3110	Natural Resource Policy (s)	3	
		28	

5. Department of Education Requirements

ED3100	Instructional Technology (f, s)	2	
ED3110	Psych. Foundations of Education (f, s)	3	PSY2000 &UN2002
ED3210	Foundations of Education (f, s)	2	UN1002, (ED3110 & ED3410 coreq)
ED3410	Clinical Experience (f, s)	1	junior standing
ED4700	Fundamentals of Instruction (f, s)	3	ED3110, ED3210, & ED3410
ED4710	Methods of Teaching Science & Math (f, s)	3	ED4700 (coreq)
ED4910	Directed Teaching (f, s)	12	ED3100, ED4700 & (ED4710 coreq)
HU4150	Literacy in the Content Areas (f, s)	4	ED3110 (pre or coreq)
		30	

Also required is EH3985 First Aid/CPR or Certification in CPR and First Aid by the American Heart Association or the American Red Cross

Highly recommended: (credits not included in total)

ENG3000	Engineering for Non-Believers	3	MA1135 & PH1110

6. Teacher Certification Minor **19-26**

Total credits required dependent on teacher certification minor chosen and any double listing of distribution courses with Dept. of Education core courses.

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.

*denotes semester offered f= fall, s= spring, su= summer

**Some distribution requirements may be met by courses required by the Dept. of Education and the teacher certification minor. See School of Forest Resources & Environmental Science advisor for details.

B.S. in Wildlife Ecology and Management with Secondary Education Option in Biology

1 Major Requirements		Credits	Prerequisites
FW1050	Natural Resources Seminar (s)*	1	
FW2010	Vegetation of North America (f)	4	
FW2051	Field Techniques (f)	1	
FW3012	Survey of Silviculture (f)	1	FW2010 & FW2051
FW3020	Forest Ecology (f)	3	FW2010 & FW2051
FW3170	Land Measurement and GPS (f)	1	FW3540
FW3180	Geomorphology, Landscapes & Ecosystems (f)	2	
FW3190	Multi-Resource Assessment (f)	3	FW3020 & MA2720
FW3200	Inventory, Monitoring and Data Analysis (s)	4	FW2051 & MA2720
FW3410	Conservation Biology (s)	3	
FW3540	Intro. to GIS for Natural Resource Mgt. (s)	4	MA2720 (pre or coreq)
FW3630	Wildlife Habitat Diseases & Parasites (f)	4	
FW3800	Insect Ecology (f)	2	
FW3840	Forest Health (f)	3	FW3020
FW4260	Population Ecology (f)	3	
FW4610	Wildlife Ecology (f)	3	FW3020 or BL3400
FW4810	Integrated Resource Assessment (f)	4	FW3540 & FW3020 & (FW3190 or FW3410)
3 of the 4 following classes:			
FW3610	Ornithology (s)	4	BL1040 or BL1020
FW4240	Mammalogy (f)	4	BL1040 & junior standing
FW4620	Herpetology (s)	3	BL1040 or BL1020
BL4440	Fish Biology (s)	4	BL1040 or BL1020
		57-58	

2. Cognate Course Requirements

BL1040	Principles of Biology (f)	4	
BL2100	Principles of Biochemistry (f)	3	BL1040 or BL1020 & CH1150 & CH1151
BL2160	Botany(s)	4	
BL2170	Zoology (f)	4	BL1020 or BL1040
BL2200	Genetics (s)	3	BL1020 or BL1040 & BL2100
BL3190	Evolution (s)	3	BL1020 or BL1040
MA1135	Calculus for Life Sciences (f, s, su)	4	MA1032 or MA1031
MA2720	Statistical Methods (f, s, su)	4	MA1032 or MA1031
CH1150	University Chemistry I (f, s, su)	3	
CH1151	University Chemistry Lab I (f,s,su)	1	
		33	

3. General Education Requirements

UN1001	Perspectives on Inquiry (f, s)	3	freshmen only
UN1002	World Cultures (s)	4	freshmen only
UN2001	Revisions (f, s)	3	UN1001 & UN1002
UN2002	Institutions (f, s)	3	UN1001 & UN1002
HASS Distribution electives**		12	
FW3110	Natural Resource Policy (s)	3	
		28	

4. Department of Education Requirements

ED3100	Instructional Technology (f, s)	2	junior standing
ED3110	Psych. Foundations of Education (f, s)	3	PSY2000 & UN2002
ED3210	Foundations of Education (f, s)	2	UN1002, (ED3110 & ED3410 coreq)
ED3410	Clinical Experience (f, s)	1	junior standing
ED4700	Fundamentals of Instruction (f, s)	3	ED3110, ED3210, & ED3410
ED4710	Methods of Teaching Science & Math (f, s)	3	ED4700 (coreq)

ED4910	Directed Teaching (f, s)	12	ED3100, ED4700 & (ED4710 coreq)
HU4150	Literacy in the Content Areas (f, s)	4	ED3110 (pre or coreq)
		30	

Also required is EH3985 First Aid/CPR or Certification in CPR and First Aid by the American Heart Association or the American Red Cross

Highly recommended: (credits not included in total)

ENG3000	Engineering for Non-Believers	3	MA1135 & PH1110

5. Teacher Certification Minor **19-26**

Total credits required dependent on teacher certification minor chosen and any double listing of distribution courses with Dept. of Education core courses.

Note: 3 credits of co-curricular activities (physical education) required but not included in overall credits needed for degree.

*denotes semester offered f= fall, s= spring, su= summer

**Some distribution requirements may be met by courses required by the Dept. of Education and the teacher certification minor. See School of Forest Resources & Environmental Science advisor for details.

Certificate in Industrial Forestry

The Certificate in Industrial Forestry is designed to give students a working knowledge of, but not expertise in, the field of forest resources and general business management.

Business Curriculum – four required classes:

EC2001 – (3) Principles of Economics
EC3400 – (3) Economic Decision Analysis
-OR-
BA3400 – (3) Principles of Finance
BA2330 – (3) Accounting I
BA3620 – (3) Project Management
OR
BA3580 – (3) Legal Environment of Business

Forestry Curriculum – four required classes:

FW1035 – (4) Wood Anatomy and Properties
FW3098 – (2) Wood Processing and Manufacture
FW2010 – (4) Vegetation of North America
FW2051 -- (1)Field Techniques

Students interested in this program should contact Mary Jurgensen (487-2953) or Blair Orr (487-2291), Forestry Advisors or Brad Wagner (487-3501), Business Advisor, for more information about the program.

Students may also consider a five-year program to obtain B.S. degrees in both Business Administration and Forestry.

This Certificate in Industrial Forestry can be obtained concurrently while working towards a degree or by part-time students pursuing no degrees. All students must, however, comply with the procedures for admission to Michigan Tech University. Michigan Tech University will award the certificate to students who have fulfilled the course requirements while maintaining a minimum grade point average of 2.50 in all courses required for the certificate. Conferral of the certificate will be noted on the student's transcript.

Minimum total credits required for the certificate: 23
Minimum total GPA in certificate courses: 2.50

Minors

The School of Forest Resources and Environmental Science offers four minors in cooperation with other departments on campus. They are:

- Ecology
- Plant Sciences
- Plant Biotechnology
- Remote Sensing

Specific requirements are outlined on the following pages. All of the minors offered at MTU can be viewed in the university catalog at: http://www.admin.mtu.edu/em/students/

Information and Guidelines for Minors

The purpose of a minor is to officially recognize a student who takes a prescribed set of courses in a discipline outside their major. To receive a minor a student must be enrolled in a Bachelor's degree program at Michigan Tech, have indicated that they are pursuing the minor, and have completed all requirements for the minor. The award will be noted on the student's diploma and official transcripts.

A student must inform Degree Services of the pursuit of a minor no later than the time when degree audits are filed with the Registrar's Office. A student cannot be awarded a minor that has the same title as their major or major concentration.

In addition to meeting the requirements specified by the academic unit offering the minor, a student must:

- Maintain a minimum cumulative grade-point average of 2.0 for courses completed as part of the minor
- Take at least six credit hours of 3000 level or higher minor-required courses that are not required as part of their major (except as free electives).
- At least six credits of the 3000 level or higher minor-required courses must be taken at Michigan Tech. Courses that meet the "at Michigan Tech" requirement are defined as courses listed in the course catalog and taught by a Michigan Tech instructor either on campus, at field locations, or through distance learning.

MichiganTech

Degree Services
Registrar's Office

School of Forest Resources and Environmental Science and Department of Biological Sciences

Interdisciplinary Minor in Ecology

IMEC

Name (please print): _____
(Last) (First) (Middle)

Student Number: _____

Primary Major:_____ Expected Major Completion Term_____

_____

Required Courses - *Select one course from group A and B:*

A.

_____ BL1040 Principles of Biology (4)

_____ BL1010 General Biology I (4)

_____ BL2160 Botany (4)

_____ BL2170 Zoology (4)

B.

_____ BL3400 Principles of Ecology (4)

Elective Courses - *Must select at least 6 credits*

_____ BL3190 Evolution (3)

_____ BL3400 Principles of Ecology* (4)

_____ BL4090 Tropical Island Biology (2)

_____ BL4450 Limnology (4)

_____ BL 4455 Rsch. Meth. Aquatic Ecology (1-3)

_____ FW3020 Forest Ecology* (3)

_____ FW3330 Soil Science (4)

_____ FW4220 Wetlands (4)

_____ FW4260 Population Ecology (3)

_____ FW4300 Introduction to Wildland Fire (3)

_____ FW4370 Forest and Landscape Hydrology 3)

_____ FW4610 Wildlife Ecology (3)

_____ FW4380 Landscape Ecology (3)

Remaining Electives - *Remaining electives may be selected from the previous Elective Courses list, or from the following:*

_____ BL4130 Phycology (3)

_____ BL4810 Plant Taxonomy (3)

_____ BL5680 Bryology (4)

_____ BL5681 Field Bryology (1)

_____ FW2010 Vegetation of North America** (4)

_____ FW3610 Ornithology (4)

_____ FW3620 Field Ornithology (1)

_____ FW4500 Independent Study (1-3)

Recommended Cognate Courses - *not part of the minor*

_____ CH1150 & 1153 Univ. Chemistry I (3) (1)

_____ CH1151 Univ. Chemistry Lab I (1)

_____ CH1160 Univ. Chemistry II (3)

_____ CH1161 Univ. Chemistry Lab II (1)

*These courses may not be double-counted as one of the required courses.

**Only 2 credits count toward the minor.

Credits Required = 16

Total Credits _____

Courses listed in this minor have the following prerequisites (shown in parenthesis). Concurrency is illustrated by the letter C: BL4130 (BL2160), FW3610 (BL1040 or BL1020), CH1120 (CH1150 and CH1151)), BL2170 (BL1010 or BL1040), BL4450 (CH1160), FW3020 (FW2010 C and FW2050 C), FW4610 (BL3400 C), BL3190 (BL1020 or BL1040), FW3330 (CH1150 C and CH1151 C), BL3400 (BL1020 or BL1040), FW4300 (FW3020 and (FW3010 or FW3012))

_____ _____

Student Date Department Advisor Date

Academic Year 2009-10

School of Forest Resources & Environmental Science and Department of Biological Sciences

MichiganTech

Degree Services
Office of Student Records & Registration

Interdisciplinary Minor in Plant Biotechnology

IMPB

Name (please print):

_____

(Last) (First) (Middle)

Student Number: _____

Primary Major:_____ Expected Major Completion Term:_____

Required Courses

_____ BL2100 Principles of Biochemistry (3)

_____ FW3075 Introduction to Biotechnology (3)

_____ BL3300 Introduction to Genomics (3)

Students are highly recommended to take 1-3 credits of Undergraduate Research (FW4500 or BL4000) in addition to the minor to gain hands-on experience. Permission of instructor is required for these courses.

Elective Courses - *Must select at least 7 credits*

_____ BL3210 General Microbiology (4)

_____ BL4010 Biochemistry I (3)

_____ BL4030 Molecular Biology (3)

_____ BL4140 Plant Physiology (3)

_____ FW4089 Bioinformatics (3)

_____ FW4120 Tree Physiology & Genetics (3)

_____ FW5070 Develop. & Ecological Genetics (3)

_____ FW5085 Funct. Genomics & Biotechnology (3)

Credits Required = 16

Total Credits _____

Courses listed in this minor have the following prerequisites (shown in parenthesis). Concurrency is illustrated by the letter C: BL4140 (BL2160 and CH2420 or CH2400)), BL4010 ((BL1020 or BL1040 or BL2010) and BL2100 and (CH2400 or CH2420) and CH2420), BL2100 ((BL1040 or BL1020) and (CH1150 and CH1151)), BL3210 ((BL1020 or BL1040) and (BL2100 or CH4710))

_____ _____

Student Date Department Advisor Date

Academic Year 2009-10

School of Forest Resources and Environmental Science and Department of Biological Sciences

MichiganTech

Degree Services
Office of Student Records & Registration

Interdisciplinary Minor in Plant Sciences

IMPS

Name (please print):

_____

(Last) (First) (Middle)

Student Number: _____

Primary Major:_____ Expected Major Completion Term:_____

Required Course

_____ BL2160 Botany (4)

Elective Courses - *Must select at least 6 credits*

_____ BL4130 Phycology (3)

_____ BL4140 Plant Physiology (3)

_____ BL4810 Plant Taxonomy (3)

_____ BL3300 Introduction to Genomics (3)

_____ FW4110 Tree Seedling Production & Greenhouse Management (1-4)

Remaining Electives - *Remaining electives may be selected from the previous 'elective' list or the following:*

_____ BL5680 Bryology (4)

_____ BL5681 Field Bryology (1)

_____ FW1035 Wood Anatomy & Properties* (4)

_____ FW2010 Vegetation of North America* (4)

_____ FW3020 Forest & Landscape Ecology (3)

_____ FW3075 Introduction to Biotechnology*(3)

_____ FW4220 Wetlands (4)

Credits Required = 16

Total Credits _____

Courses listed in this minor have the following prerequisites (shown in parenthesis). Concurrency is illustrated by the letter C: BL4140 (BL2160 and CH2420 or CH2400)), FW3020 (FW2010 C and FW2051C), BL4130 (BL2160)

_____ _____

Student Date Department Advisor Date

Academic year 2009-10

Biological Sciences, Chemistry, Civil & Environmental Engrg, Computer Science, Electrical & Computer Engrg, Forest Resources & Environ Sciences, Geological & Mining Engrg, Mathematical Sciences

MichiganTech

Degree Services
Office of Student Records & Registration

Interdisciplinary Minor in Remote Sensing

IMRS

Name (please print): _____
(Last) (First) (Middle)

Student Number: _____

Primary Major:_____ Expected Major Completion Term: _____

Required Courses

_____ UN 4000 Remote Sensing Seminar (1)

Select one of the following two courses:

_____ FW 4540 Remote Sensing of the Environment (3)

_____ GE 4250 Fundamentals of Remote Sensing (3)

Elective Courses *(Data Acquisition & Processing)*

Select 3-6 credits from the following:

_____ EE 2150 Intro to Signal Processing (3)

_____ EE 3140 Electromagnetics (3)

_____ EE 4252 Digital Signal Processing (4)

_____ EE 5500 Statistical Signal Processing (3)

_____ EE 5520 Fourier Optics (3)

_____ FW 5560 Digital Image Processing: A Remote Sensing Perspective (4)

_____ GE 4250 Fundamentals of Remote Sensing (3)
(Do not select if selected under Required Courses above).

_____ PH 2230 Electronics for Scientists (4)

_____ PH 3210 Geometrical & Physical Optics (4)

Elective Courses *(Data Management)*

Select 3-6 credits from the following:

_____ CE 5661 GIS Applications (3)

_____ CS 2090 Special Topics in CS (3)

_____ CS 3621 Geometric Objects and Processing (3)

_____ CS 4611 Foundations of Computer Graphics (3)

_____ FW 3540 Intro to GIS for Natural Resource Management (4)

_____ FW 5550 Geographic Information Systems (4)

_____ GE 4160 Introduction to Subsurface GIS (3)

_____ MA 3730 Statistical Methods II (3)

_____ MA 4515 Intro to Partial Diff. Equations (3)

_____ MA 4610 Numerical Linear Algebra (3)

_____ MA 4710 Regression Analysis (3)

_____ MA 5701 Statistical Methods (3)

_____ MA 5741 Multivariate Statistical Methods (3)

_____ MA 5980 Special Topics in Mathematics (3)

Courses listed in this minor have the following prerequisites (shown in parenthesis). Concurrency is illustrated by the letter C: EE3140 (PH2200 and MA3160), CE5661 (CE3620), CE5509 (CE4501 or CH3510), CH5509 (CE4501 or CH3510), CE5505 (CE4504 or CE4501), PH2230 (PH2200 or PH2260), MA4515 ((MA3520 or MA3521 or MA3530 or MA3560) and MA3160), CE4501 ((CE3501 or CE3503) and CE3502 and CH3500 C), CS3621 (MA2160 and (MA2330 or MA2320 or MA2321) and CS2141), MA3730 (MA2710 or MA2720 or MA3710), CE3620 (ENG3200 and (MA3710 C or CE3502) C), CS4611 (CS2141), EE2150 (MA2160) and (CS1121 or CS1131)), MA4710 (MA2720 or MA3710 or MA2710), FW3540 (MA2720 C or MA2710 C or MA3710 C), PH4080 (PH3480), MA5741 ((MA4710 or MA4720) and MA5701), GE4150 ((GE2000 or GE2100) and UN2002), GE4250 (PH2200 and (MA2150 or MA2160)), EE5520 (EE3190), FW5560 (FW5540), FW5550 (MA2720 or MA2710 or MA3710), EE4252 (EE3160 and EE2150 and EE2150), MA4610 (MA2320 or MA2321 or MA2330), PH3210 (PH2400 and (MA3520 or MA3521 or MA3530 C or MA3560))

(Requirements are continued on reverse side)

Minor in Remote Sensing (continued)

Elective Courses *(Data Analysis and Applications)*
Select 3-6 credits from the following list:

_____ BL5520 Satellite Limnology (3)

_____ CE3620 Water Resources Eng (4)

_____ CE4501 Environ Eng Chem Processes (4)

_____ CE4504 Air Quality Engineering & Science (3)

_____ CE5515/CH5515/CE4515/CH4515 Atmospheric Chemistry (3)

_____ CE/CH5509 Environ. Organic Chemistry (3)

_____ FW4540 Remote Sensing of the Environment (3)
(Do not select if selected under Required Courses above).

_____ GE2500 Introduction to Oceanography (3)

_____ GE2640/PH2640 Atmospheric Observ & Meteor (3)

_____ GE4150 Natural Hazards (3)

_____ GE5150 Advanced Natural Hazards (3)

_____ UN4000 Remote Sensing Seminar (1)
(1 credit of UN4000 may be used in addition to the 1 credit of UN4000 that is required).

_____ PH4640 Intro to Atmospheric Physics (3)

Elective Courses *(Independent Study/Senior Research)*
Select 0-3 credits from the following:

_____ BL4000 Special Problems in Biology (3)

_____ CE4510 Baccalaureate Thesis (3)

_____ CH4990 Undergrad. Research in Chemistry (3)

_____ CS4090 Special Topics in CS (3)

_____ EE4800 Special Topics in EE (3)

_____ FW4500 Independent Study (3)

_____ GE4960 Independent Geol. Eng. Res. Project (3)

_____ MA4990 Topics in Mathematics (3)

_____ PH4080 Senior Research I (3)

Credits Required = 16

Total Credits _____

_____
Student Date

_____
Department Advisor Date

Study Abroad,
Your Career and Your Class Schedule

Several hundred companies were surveyed to determine what they look for during the hiring process. Here, in order, are the top 14.

1.) Problem solving skills
2.) Communication skills (both oral and written)
3.) Ethics and professionalism
4.) Open mindedness and a positive attitude
5.) Math and science proficiency
6.) Technical skills
7.) Motivation for continuous learning
8.) Business management practices
9.) World affairs
10.) Co-ops and internships
11.) Teamwork Skills
12.) Leadership
13.) Confidence
14.) Projects and accomplishments

While world affairs is number nine on the list, many aspects of study abroad also give you experience and background in other areas. Your study abroad experience can be used to illustrate more of the other traits in this list.

Remember, if you plan ahead, some study abroad classes count towards your HASS distribution requirements.

NOT ONLY IS STUDY ABROAD FUN, BUT YOU CAN FIT IT IN TO YOUR SCHEDULE!

See Dr. Blair Orr, room 145A, for more information.

COURSE DESCRIPTIONS

Course — Credits

FW1035 Wood Anatomy and Properties (3-0-3) s — **4**
An introduction to the micro-and macro-anatomy of wood, how wood structure is related to its function in the tree, wood quality, physical properties, and its utilization as an industrial raw material.

FW1050 Natural Resources Seminar (1-0-0) s — **1**
Seminar introduces students to the various careers within forestry, conservation, ecology and wildlife that represent specialties within natural resources.

FW2010 Vegetation of North America (2-1-3) f — **4**
Identification of trees and shrubs. Study of seed dispersal, dormancy, seedbed requirements, shade tolerance, life span and ecology, with an emphasis on trees. Systematic study of the major forested vegetation types of North America.

FW2051 Field Techniques (0-0-3) f — **1**
Equipment and techniques used to measure forest ecosystem attributes and perform fieldwork. 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.

FW3010 Practice of Silviculture (2-1-3) f — **4**
Methods of controlling the establishment, growth, composition, health and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis. Prerequisites: FW2010 and FW2051.

FW3012 Survey of Silviculture (0-0-2) f — **1**
An introduction to the practice of silviculture, including ecological principles which form the basis for forest management. The course emphasizes proper use of silviculture terminology, and includes field examples of management practices. Prerequisites: FW2010 and FW2051.

FW3020 Forest Ecology (2-0-3) f — **3**
Gain a basic understanding of how forest ecosystems function across various temporal and spatial scales. Emphasizes real-world problems and the skills necessary to resolve land-use conflicts and to manage terrestrial ecosystems.
Pre- or co-requisites: FW2010 and FW2051 .

FW3075 Plant Biotechnology (3-0-0) s — **3**
Basic concepts and practical applications of biotechnology and genetic engineering. Topics include advances and practical applications relating to improving quality and field performance of agricultural crops, environmental remediation, and phyto-pharmaceutics. Recent advances in gene containment, regulatory, societal and environmental issues associated with field release or commercialization of genetically modified organisms will be discussed.

FW3098 Wood Processing and Manufacture (1-0-3) f — **2**
A huge variety of products are manufactured from wood. Wood-based manufacturing plants in the upper Midwest are visited during the week prior to the start of the fall semester. Plant similarities and differences are discussed during class meetings. Prerequisite: FW1035.

FW3110 Natural Resource Policy (3-0-0) s **3**
This course will cover concepts related to social systems and natural resources, as well as offer a survey of natural resource policies and organization. State and federal levels of policymaking will be linked to the human values, attitudes and beliefs which set the context for natural resource policy processes.

FW3150 Timber Harvesting (1-0-3) f **2**
Methods and techniques used in timber harvesting systems. Emphasizes best management practices, aesthetic and ecological impacts, logging cost analysis, timber appraisal, and timber sale preparation and administration. Prerequisite: FW2051.

FW3170 Land Measurements and GPS (0-0-3) f **1**
Introduces field measurements and computations involved in determining direction, distance, and area. Covers the hand compass, pacing and use of GPS, including differential correction. Integration of GPS data with GIS is emphasized. Prerequisite: FW3540, Co-requisite: FW3190.

FW3180 Geomorphology, Landscapes and Ecosystems (1-0-3) f **2**
Provides basic understanding of the geologic and glacial processes that shaped the landscape of the upper Midwest, influencing the distribution and productivity of modern-day plant communities. Topics include: geology of Michigan, glacial geomorphology, soil development, landscape and community ecology, forestry. Prerequisite: sophomore standing.

FW3190 Multi-resource Assessment (0-1-6) f **3**
Students develop a basic proficiency in the application of multiple-resource measurement techniques, become familiar with the application of individual tree and landscape measurements, estimation of growth, sampling techniques, computational procedures, and mapping procedures commonly used in forest and land management. Prerequisites: FW2051 & FW3020 & MA2720 & FW3200.

FW3200 Inventory, Monitoring and Data Analysis (3-0-3) s **4**
Sampling design, implementation and analysis for inventory and monitoring of attributes of stands, forests and landscapes. Includes computing skills for data entry, storage and analysis and application of statistical techniques to answer questions about ecological data. Prerequisites: FW2051 and (MA2720, MA2710 or MA3710)

FW3300/BL3300 Introduction to Genomics (3-0-0) f **3**
Introduction to genome structure organization and analysis. Topics covered include various Aspects of organization and structure of genomes, rationale for genome mapping, Assembling of physical maps, strategies and techniques for genome sequencing and analysis Prerequisite: BL2200

FW3330 Soil Science (3-0-3) f **4**
Introduction to the chemical, physical, and biological properties of soils.
Co- or prerequisite: CH1100 or (CH1150 and CH1151).

FW3376 Forest & Environ. Resource Management I (The FERM) f, s, su **2**
Application of forest and environmental management practices by teams of students with the assistance of faculty, staff and representatives of state, federal and corporate land management groups as well as non-governmental organizations. Pre-requisites: FW2010 & FW2051.

FW3377 Forest & Environ. Resource Management II (The FERM) f, s, su **3**
Application of forest and environmental management practices by teams of students with the assistance of faculty, staff and representatives of state, federal and corporate land management groups as well as non-governmental organizations. Pre-requisites: FW2010 & FW2051.

FW3378 Forest & Environ. Resource Management III (The FERM) f, s, su **4**
Application of forest and environmental management practices by teams of students with the assistance of faculty, staff and representatives of state, federal and corporate land management groups as well as non-governmental organizations. Pre-requisites: FW2010 & FW2051.

FW3410 Conservation Biology (3-0-0) s **3**
Introduction to biological, social, political, and economic facets of conservation biology. Emphasis placed on evaluation of how best to maintain and restore biodiversity through management of populations and ecosystems. Topics include mass extinctions and global change, degradation and loss of habitat, and over exploitation of biological resources.

FW3540 Intro. to Geographic. Information Systems for Natural Resource Mgmt. (3-0-3) s **4**
The fundamentals of GIS and its application to natural resource management. Spatial data, its uses and limitations are evaluated. Students work extensively with ArcGIS software package. Co- or prerequisite: MA2720.

FW3600 Wildlife Habitat (2-0-3) f **3**
To understand the ecological basis for management of forest wildlife and how forest management influences wildlife populations. Laboratory includes an introduction to techniques in wildlife research and management, especially methods of habitat analysis. Prerequisite: sophomore standing.

FW3610 Ornithology (3-0-3) s **4**
An ecological and evolutionary approach to the study of birds. Topics include behavioral, anatomical, and physiological adaptations to flight, life history, mating systems, migration, communication, and conservation. Laboratory emphasizes identification and experimental use of birds as model organisms**.** Prerequisite: BL1040 or BL1020.

FW3620 Field Ornithology (to be arranged) su **1**
An introduction to field techniques and identification. Weekend trip to Whitefish Point Bird Observatory during spring migration and field note taking.

FW3630 Wildlife Habitat, Diseases and Parasites (2-1-3) f **4**
Understand the ecological basis for management of forest wildlife and how forest management influences wildlife populations. Laboratory introduces techniques in wildlife research and management, especially methods of habitat analysis. Includes an introduction to common mathematical models used in population ecology. Prerequisite: sophomore standing

FW3760/SS3760 Human Dimensions of Natural Resources (3-0-0) f **3**
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.

FW3800 Insect Ecology (1-1-0) f **2**
Insects are widespread and diverse components of terrestrial and aquatic ecosystems This course will consider some of the many aspects of insect ecology, including biodiversity and conservation of insects, the effects of biotic and abiotic factors on insect populations, evolutionary ecology of insects, and the trophic diversity of insects.

FW3840 Forest Health (1-1-3) f **3**
Drawing on examples from the Great Lakes region, and other parts of North American, this course will consider which type of insects and pathogens attack our trees and forests, how they interact with each other, and what tools we can use to effectively reduce their negative impacts of forest pests. Prerequisite: FW3020

FW4000 Professional Experience Program (to be arranged) f,s,su **1**
Students create oral/written report based on paid or volunteered work or field experience in natural resources.

FW4080 Forest Economics and Finance (2-0-2) s **3**
Financial analysis and economic theory applied to forestry project analysis and selection, focusing on prices. Covers risk, capital markets, taxation, auction and non-market valuation.

FW4089 Bioinformatics (2-0-2) s alternate years **3**
Computer applications in molecular biology, hands-on experience with using popular computer programs for DNA, RNA and protein sequence analysis, database management, data editing, assembly, and organization, multiple sequence comparisons, protein structural analysis, evolutionary relationships of genes, comparison and analysis. Prereq.: Sr. standing.

FW4110 Tree Seedling Production & Greenhouse Management (to be arranged) s **1-4**
Greenhouse culture of trees from seed or vegetative cuttings are demonstrated. Topics include: production of containerized seedlings, vegetative propagation via budding, grafting and rooting of cuttings, and genetic manipulation. Students are given "hands on" roles in the routine greenhouse culture such as media preparation, pest management, and fertilization. Prerequisite: junior standing.

FW4120 Tree Physiology and Genetics (3-0-0) s **3**
This course will serve as an introduction to the genetics and physiology of forest trees. A basic understanding of how trees grow and develop and why they vary from tree to tree will be developed. In addition, modern methods to improve forest trees will be covered.

FW4140 Vegetation Modeling (3-0-3) s **2**
Use of models in research and management of terrestrial ecosystems. Teaches application with emphasis on philosophy; models as tools, design goals and approaches, and interpreting the meaning and significance of model outputs. Prerequisite: FW3010 or FW3012.

FW4150 Forest Resource Management (2-0-3) f **3**
Methods of organizing forest properties for sustainability and multiple-use management using operations research methods, particularly linear programming, for selecting preferred options. Developing an understanding of the strengths and weaknesses of the models used is emphasized. Single- and multiple-use land management formulations are discussed. Prerequisites: FW3010 & FW4080.

FW4170 Consulting Forestry (2-0-0) su **2**
For students who are considering consulting forestry as a career. Covers issues specific to working with private landowners, stewardship plan writing, choosing a business entity, marketing, taxes, income/expenses, insurance, timber sale administration, and resolving landowner disputes.

FW4220 Wetlands (3-0-3) f **4**
Study of physical, chemical, and biological characteristics of wetlands. Functions and values of individual wetland types will be described. Present management of wetlands and laws governing wetlands will also be presented. Labs will concentrate on field techniques used to assess specific plant, animal, soil, and hydrological characteristics of wetlands.

FW4240 Mammalogy (3-0-3) f **4**
To understand the classification, structure, and natural history of mammals, including physiological, behavioral and ecological adaptations. Through laboratory and field work, to become familiar with field techniques plus the distribution and identification of mammals, especially those species in the western Great Lakes. Prerequisites: BL1040 and junior standing.

FW4260 Population Ecology (3-0-0) f **3**
Covers the principles of population ecology. Topics includes measures of populations, population dynamics, and models used to describe the theories related to population dynamics.

FW4300 Introduction to Wildland Fire (3-0-0) s **3**
An introduction to wildland fire based on an understanding of fuel properties, fire behavior, ecological effects and management. Prerequisites: FW3020, (FW3010 or FW3012) and junior standing.

FW4370 Forest and Landscape Hydrology (3-0-0) s **3**
The course will use a process-based approach to present the physical hydrology, geomorphology and water quality of forested watersheds. The course will focus on the interaction between watershed processes and forest management.

FW4380 Landscape Ecology (0-3-0) s **3**
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.

FW4400 Urban Forestry (2-0-3) s **3**
Urban forestry deals with the planting and maintenance of trees in urban settings. Modern arboriculture and tree care methods are presented, and administration of urban forests discussed. Topics covered include pest management, pruning, planting, fertilization, inventories, tree selection, and line clearance. Labs include experience in tree climbing, pruning, and planting.

FW4500 Independent Study (to be arranged) f,s,su **1-7**
Guided study or research on an approved forest resource topic with a chosen faculty member. Prerequisite: Prior permission of faculty member.

FW4540 Remote Sensing of the Environment (2-1-0) f (alternate years) **3**
Overview of remote sensing principles and concepts. Topics include camera and digital sensor arrays, various types of imagery, structure of digital data, spectral reflectance curves, applications/case studies and introduction to digital image processing. Prerequisite: junior standing

FW4610 Wildlife Ecology (3-0-0) f **3**
To understand the ecological basis for management of wildlife, including biological and sociological factors which influence management. Co- or prerequisite: BL3400 or FW3020 and junior standing.

FW4620 Fundamentals of Herpetology (3-0-0) s (alternate years) **3**
The biology of amphibians and reptiles, including evolution, zoogeography, ecology, behavior and physiology. Prerequisite: BL1040 or BL1020.

FW4634 Conservation Issues in Yellowstone (0-3-9) su **6**
Yellowstone has a rich, complex history of conservation challenges. This course will provide in-depth explorations of conservation controversies occurring in Yellowstone, first in an MTU classroom, followed by an 8-day visit to the Park. The course takes place in summer; dates vary.

FW4638 Wolf Ecology and Management (2-0-2) su **3**
This course covers wolf ecology, current status and management of wolf populations throughout the U.S., wolf/prey dynamics, and field techniques utilized in the study of wild wolves. The course begins in the classroom followed by a 4-day field trip. The field trip (camping) includes observation of captive wolves at the International Wolf Center, experience locating wild wolves (radio telemetry, howling surveys, wolf sign in the field) and a visit with wolf researchers.

FW4810 Integrated Resource Assessment I (0-3-3) f **4**
Provides a capstone experience by integrating techniques from many of the applied ecology and forestry core courses. Covers multiresource inventory of forested landscapes; description and evaluation of the potential for providing various natural resource outputs; development of GIS information and applications, maps, and other descriptors useful in the analysis of diverse management alternatives. Prerequisites FW3540, FW3020, and (FW3190 or FW3410).

FW4850/ED4850/BL4850 Environmental Education (2-1-1) **4**
This course prepares students to design and conduct environmental education programs for adults and youth in classrooms, parks, museums, nature centers, and statewide outreach programs using a variety of teaching methods, hands-on activities, and scientific investigations.

FW5000 Distinguished Ecologist Lecture Series (1-0-0) f **1**
An opportunity to meet with some of the world's leading ecologists and to discuss their research. Pre-and post-lecture meetings enable students to review some of the research and discuss how it has impacted the field of ecology. Prerequisite: graduate standing

FW5020 Identification and Biology of Forest Vegetation (1-0-3) f **2**
Emphasis will be placed on survival and regeneration strategies of forest vegetation. Includes systematic study of the major vegetation types of North America. An independent project component may be required.

FW5032 Integrated Forest Inventory and Data Analysis (2-0-3) s **3**
Sampling approaches for estimating overstory, understory, wildlife, and abiotic attributes in forested ecosystems. Includes parameter estimation at different scales such as stand, forest, and landscape and emphasizes data management and statistical analysis techniques. Pre-requisite: graduate standing

FW5070 Developmental and Ecological Genetics (1-2-0) f **3**
Course will provide current knowledge on signal perception, transduction and response pathways in higher eukaryotes with most examples primarily from but not limited to plants in a lecture and colloquium format. Topics will cover major developmental pathways, and molecular bases of adaptation to biotic and abiotic factors. Prerequisite: BL5030

FW5080 - Gene Profiling Analysis (0-2-3) s **3**
Advanced training in modern molecular techniques with an emphasis on gene expression analysis. Discussion of various gene profiling methods and their applications. Hands-on laboratory exercises and data analysis. Prerequisite: Graduate standing

FW5085 Functional Genomics and Biotechnology (3-0-0) f **3**
Fundamentals and practical applications of functional genomics tools in biological research. Topics include transcript profiling, regulation of gene expression, mechanisms of gene silencing, genetic transformation, and high throughput DNA microarray and metabolic profiling technologies. Prerequisite: senior or graduate standing

FW5088 Forest Finance and Economics (2-0-2) s **3**
Financial analysis and economic theory applied to forestry project analysis and selection, focusing on prices. Covers risk, capital markets, taxation, auctions and non-market valuation. Prereq.: graduate standing.

FW5089 Tools of Bioinformatics (2-1-2) s (alternate years) **4**
Computer applications in molecular biology. Hands-on experience using popular computer programs for DNA, RNA and protein sequence analysis, database management, data editing, assembly, and organization, multiple sequence comparisons, protein structural analysis, evolutionary relationships of genes, use of Internet for data retrieval, comparison and analysis. Prerequisite: graduate standing.

FW5098 Advanced Wood Processing f (1-0-3) **2**
Wood is an abundant and widely used raw material. Wood-based manufacturing plants in The upper Midwest are toured during the week prior to the start of the fall semester. Plant characteristics are discussed during the class meetings. Prerequisite: graduate standing

FW5100 Advanced Terrestrial Ecology (2-0-2) s **3**
Structure and function of terrestrial ecosystems. Roles of ecotypic variation, animals ,natural disturbance, biological diversity, management, and global change on plant community dynamics and ecosystem processes. Prerequisite: graduate standing and instructor permission.

FW5109 Ecophysiology of Global Change (2-0-2) s (alternate years) **3**
Physiological responses of plant species to climatic variation and change, pollutant deposition and altered atmospheric conditions; potential futures changes in the distribution and function of species, communities and ecosystems.

FW5111 Advanced Natural Resource Policy (3-0-0) f (alternate years) **3**
This course surveys basic important federal policies related to water, land, forest, mineral, and wildlife and fisheries management. It uses policy analysis tools to understand the theory and study of policy development and implementation.

FW5115 - Restoration Ecology (3-0-0) s (alternate years) **3**
Study the tools, challenges, and philosophical underpinnings associated with ecological restoration. Restoration of forest, grassland, and wetland communities (plant and animal) will be discussed. Prerequisite: Graduate standing.

FW5130 Forest Vegetation Dynamics (2-1-0) s (alternate years) **3**
Investigation of how trees grow and interact in a variety of stand structures from a functional standpoint at both the tree- and stand-level. These principles will be used to test the use of silvicultural management tools for meeting a variety of objectives. Linkages will be made between stand development patterns and management options, with an emphasis on disturbance ecology. Prerequisites: FW3020 or FW3010 or BL3400

FW5150 Institutions and Natural Resource Management (variable to 3) f, s, su **3**
Course examines how institutions manage natural resources to meet their legal and social requirements and the demands of constituencies. Emphasis is on case study applications. Prerequisite: Graduate standing.

FW5180 Philosophy of Ecology (0-2-0) f (alternate years) **2**
This course covers material concerning the philosophy of science as it relates to ecological science and environmental ethics as it relates to natural resource management
Pre-requisite: graduate standing

FW5210 Organisms and Their Environment (2-0-0) s (alternate years) **2**
Studies the quantitative exchange of radiation, heat, mass and momentum between the atmosphere, vegetation, and soils with an emphasis on forest processes. Other topics include the physical and biological controls of water vapor exchange and carbon dioxide exchange, models of stand-scale evaporation, transpiration, photosynthesis and respiration.

FW5220 Advanced Wetland Ecology (0-1-0) f (alternate years) **1**
Advanced study of the physical, chemical, and biological characteristics of wetlands, concentrating on recent research in wetland ecology. Labs will emphasize field techniques used to assess specific plant, animal, soil and hydrological characteristics of wetlands. Prerequisite: graduate standing.

FW5350 Soil Biology (3-1-0) s (alternate years) **4**
Ecology of soil microorganisms and fauna and their roles in soil organic matter decomposition and nutrient cycling. Prerequisite: FW3330 or BL3210.

FW5376 Advanced Forest and Environmental Resource Management I f, s, su **1**
Application of forest and environmental management practices and topical investigations by teams of students with the assistance of faculty, staff and representatives of state, federal and corporate land management groups as well as non-governmental organizations.

FW5377 Advanced Forest & Environ. Resource Management II f,s,su **2**
Application of forest and environmental management practices and topical investigations by teams of students with the assistance of faculty, staff and representatives of state, federal and corporate land management groups as well as non-governmental organizations.

FW5400 Advanced Conservation Biology (4-0-0) s **4**
This course examines the biology that underlines our attempts to conserve genetic, species, and community diversity. Discussion will include current issues from the primary literature and applications to student research projects. Prerequisite: graduate standing.

FW5410 Analysis of Natural Resource Data (3-0-0) s (alternate years) **3**
Design and analysis of univariate experiments using analysis of variance (ANOVA) and related techniques. Topics covered include factorial experiments and use of blocking and covariance analysis to control experimental error. Prerequisites: MA5701, graduate standing

FW5411 - Applied Regression Analysis (3-0-0) s (alternate years) **3**
Regression as a tool for the analysis of forest and environmental science data. Topics include multiple linear, curvilinear and non-linear regression, hierarchical and grouped data and mixed-effects models. Emphasis is placed on application of tools to real-world data.
Prerequisite: Graduate standing

FW5412 Regression with the R Environment for Statistical Computing s (0-1-0) **1**
Use of R for basic data manipulation, statistical summary ad regression. Topics include installing R, data import and export, basic statistics, graphics and fitting of linear, non-linear and mixed-effects models. Prerequisite: Graduate standing. Co-requisite: FW5411

FW5510 Special Topics in Natural Resources **1-9**
Independent study of a specific area of natural resources. Prereq.: graduate standing.

FW5540 Advanced Terrestrial Remote Sensing (2-1-3)f (alternate years) **4**
Remote sensing principles and concepts at the graduate level. Topics include camera and digital sensor arrays,.types of imagery, digital data structures, spectral reflectance curves, applications and introductory digital image processing. Students are required to develop and complete a remote sensing project. Pre-requisite: graduate standing.

FW5550 Geographic Information Systems for Resource Management (3-0-3) f **4**
Use of geographic information systems (GIS) in resource management. Studies various components of GIS in detail, as well as costs and benefits. Laboratory exercises use ArcGIS software package to solve resource management problems. Prerequisites: MA2720, senior standing.

FW5560 Digital Image Processing:
A Remote Sensing Perspective (3-0-3) s (alternate years) **4**
Presents the theory and quantitative procedures of digital image processing with a remotely sensed data. Image acquisition, preprocessing, enhancement, transformation, classification techniques, accuracy assessment, and out products are emphasized. Linkages to GIS are discussed. Also covers evaluating applications of the technology to current resource management problems via the peer-reviewed literature. Prerequisites: FW4540, senior standing.

FW5620 Herpetology (0-3-0)s (alternate years) **3**
The biology of amphibians and reptiles, including evolution, zoogeography, ecology, behavior and physiology. Pre-requisite: graduate standing

FW5641/ED 5641 - Global Change Institute for Teachers (0-3-0)) su **3**
This course provides teachers with the skills necessary to engage middle/high school students in a real-world study of global climate change and its effects on ecosystems. Addresses National Content Standards for mathematics and life, earth and physical sciences.

FW5700 Graduate Field Forestry (3-0-15) f **8**
Field skills in mapping/GPS work, forest diseases and insects, wildlife, timber harvesting, natural resource inventory and silviculture for graduate students without an undergraduate degree in forestry or a closely related field.

FW5701 - Graduate Field Applied Ecology (3-0-15) f **8**
Field skills in mapping/GPS work, forest diseases and insects, wildlife, vegetation geomorphology, natural resource inventory and silviculture for graduate students without an undergraduate degree in environmental science or a closely related degree.

FW5710 Trees in Agricultural Systems (2-0-0) s **2**
Farm systems analysis and the role of trees in tropical farming systems. Also, specific material on soil conservation and tropical crops. Prerequisite: senior standing.

FW5720 International Forestry Seminar (0-1-0) f,s,su **1**
Seminar for students who have completed FW5730. Synthesizes field work in a theoretical framework. Covers macro aspects of development theory. Prerequisites: FW5730 and graduate standing.

FW5730 Field Work in International Forestry f,s,su **1**
Field work and reporting from students in the Peace Corps Loret Miller Ruppe Masters International Program in Forestry. Prerequisite: graduate standing.

FW5740 Overseas Research (0-1-0) f **1**
An introduction to conducting research overseas. Scientific methods, ethics and responsibilities in other cultures, social research, and research development are covered. Prerequisites: graduate standing.

FW5760 Graduate Tropical Forestry (0-1-0) f **1**
Fundamental ecological processes in tropical forests, traditional use including tenure, current problems and solutions to those problems. Prerequisite: junior standing & instructor permission.

FW 5770 - Rural Community Development Planning and Analysis **2**
Context, analysis, and monitoring of development processes of rural communities in tropical countries.

FW5800 Master's Graduate Seminar f,s,su **1**
Presentation by students of current forest resource-related problems and research. Some instruction on presentation skills. Prerequisite: graduate standing.

FW5810 Research Methods in Natural Resources (2-0-0) f **2**
An overview of science and scientific research.. The process of graduate education including choosing an advisor, selecting a research problem., writing a thesis proposal, scientific hypothesis testing, analyzing data, and communicating results through various media.

FW5850 - Effective Grantsmanship Workshop (1-2-0) s **3**
Ability to write successful grant application is an important part of graduate education. Students will learn basic techniques of grant writing for federal, industrial, and international funding agencies and will submit a well-organized proposal for peer review in the class.

FW5998 Forest Resources and International Forestry Master's Research f, s, su **1-9**
An original investigation in theoretical or experimental natural resources and submission of a thesis or report in partial fulfillment of the requirements of the Master of Science degree conducted while in a Peace Corps program. Prerequisite: graduate standing

FW5999 Forest and Environmental Science Master's Research f,s,su **9-12**
An original investigation in forest science, ecology, and forest molecular genetics that culminates in a Master's degree. Prerequisite: graduate standing.

FW6800 Doctoral Graduate Seminar f,s,su **1**
A seminar course in which current forest resource-related problems and research are presented by students in the class. Some instruction on presentation skills. Prerequisite: graduate standing.

FW6980 Graduate Teaching f,s **2-4**
Development of teaching skills through assisting in the instruction of a forestry/wood science course. Students gain experience in course organization, lecture and laboratory instruction, and laboratory preparation. May be repeated for a maximum of 4 credits. Graded on a pass/fail basis. Prerequisite: graduate standing.

FW6999 Forest and Environmental Science Doctoral Research f,s,su **1-15**
An original investigation in theoretical or experimental forestry or both, and submission of a dissertation in partial fulfillment of the requirements of the Ph. D. degree. Prerequisite: graduate standing