Texas Tech University
Academic Council
Meeting of August 17, 2010
1:30 PM, Provost's Conference Room

AGENDA

1. Minutes of the July 2010 meeting (attached)
2. Alcohol.edu (Jan Childress)
3. Arid Land Studies Master's Degree Proposal (elbow; attached)
4. THECB Academic Correspondence (Paton)
5. Semester Grades for Carry-over Courses, e.g., Independent Studies, Theses, etc. (Duran)
6. Debriefing on August Commencements (Syma, Rohring)
7. Other

Adjourn by 3:00

ACADEMIC COUNCIL
Texas Tech University

Meeting of
July 20, 2010

MINUTES

Present: Ralph Ferguson for Wendell Aycock, Bruce Bills, Laura Bosh, Wesley Cochran, Geleah Sharp for Cathy Duran, Gary Elbow, Amy Murphy for Greg Elkins, Jen Myants for Erica Griffin, Bob Henry, Sheila Hoover, Norm Hopper, Lynn Huffman, Patrick Hughes, Jorge Iber, Peggy Johnson, Cheryl Hedlund for Sue Jones, Michelle Kiser, Dale Ganus for Bobbie Latham, Ethan Logan, Hossein Mansouri, Pat McConnel, Walt Oler, Valerie Paton, DaNay Phelps, Beverly Pinson, Marjean Purinton, David Roach, Brian Shannon, Rosslyn Smith, Brian Steele, Rob Stewart (chair), Kevin Stoker, Janessa Walls, Jeanine Reynolds for Vicki West

Guests: Joshua Barron, Elizabeth Teagan

The Academic Council reviewed the minutes from June 15, 2010. Shannon noted that he was at the meeting and asked that the minutes be corrected. Smith moved to accept the minutes as corrected, Huffman seconded the motion, and the motion passed.

Stewart presented the July course approval summary. Henry moved the courses be accepted as presented, Hopper seconded the motion, and the motion passed.

Stewart informed the council that Dr. Juan Munoz has been named vice provost for undergraduate education. Munoz, who is also vice president of institutional diversity, equity and community engagement, will oversee the areas of academic advising and retention and community college and transfer relations.

Stewart reminded council members to keep the Academic Council informed about new minors, concentrations and emphases by placing the items on the agenda as informational items. He then informed the council that the curriculum in the Department of Construction Engineering and Engineering Technology has been modified to include two emphases: a general contractor emphasis and a mechanical/electrical subcontractor emphasis.

Stewart noted that despite an expected record enrollment, fall classes are still available when they are needed.

Ganus described his efforts to develop an online "u.select" transfer planning utility for transfer students and advisors at 10 community colleges that have been identified as sending the most students to Texas Tech. U.select allows transfer students to see how their classes will transfer into their chosen degree plan at Texas Tech. Ganus hopes to launch the new program in spring 2011.

Barron updated the council on a new online capability being developed by University Advising to allow students and advisors to check open seats by core curriculum category. This new advising tool will assist students during registration by updating the total seats available every hour. To view the available seats for fall core classes, go to www.depts.ttu.edu/actt/axis/plugins/openseats/opencore.php#pageNav.

Stewart reminded council members about President Bailey's July 1 memo regarding volunteers for recruiting events. Those individuals who handle student recruiting in each college and/or department should contact the president's office.

Henry discussed the problems created when signatory approval is not obtained for minors and concentration areas pursued by University College students seeking a Bachelor of General Studies or a B.A./B.S. in University Studies. Lack of signatory approval from colleges and departments with authority for those study areas hinders future planning for available classes and seats within classes. Phelps mentioned that future planning may be helped by the possible adoption of a new platinum analytics software program to determine and project seats years in advance based on degree audits.

Other business brought before the council included the following:

- Paton updated the council on House Bill 2504, which mandates that universities must post faculty curriculum vitae, syllabi, and published works online by fall 2010. The house bill applies only to undergraduate courses and faculty members who are "Instructor of Record" for those courses. Paton emphasized the importance of having the information uploaded into Digital Measures as soon as possible after the portal is deployed on August 15. The deadline for Texas Tech compliance for the fall semester is the seventh day of classes, September 3.
- Paton also emphasized the importance of every degree program in each college having learning outcomes, assessment activities, findings, and use of findings for improvement from 2006 forward uploaded into TracDat. All programs have to be documented by August 31, and every dean will have to review and track every program beginning September 1.

New Program Request for Master's Degree
Arid Land Studies

Table of Contents

Certification Form for New Bachelor's and Master's Programs
Texas Higher Education Coordinating Board

Directions: An institution shall use this form to request a new bachelor's or master's degree program that meets all criteria for automatic approval in Coordinating Board Rules, Chapter 5, Subchapter C, Section 5.44: (a) The program has institutional and governing board approval; (b) the program complies with the *Standards for Bachelor's and Master's Programs;* (c) adequate funds are available to cover the costs of the new program; (d) new costs during the first five years of the program will not exceed $2 million; (e) the program is a non-engineering program (i.e., not classified under CIP code 14); and (f) the program will be offered by a university or health-related institution.

If a new bachelor's or master's program does not meet the criteria above, an institution must submit a request using the *Form for Requesting a New Bachelor's and Master's Degree Program.*

Information: Contact the Division of Academic Affairs and Research at 512/427-6200 for more information.

Administrative Information

1. Institution:
   Texas Tech University

2. Program Name: Show how the program would appear on the Coordinating Board's program inventory (*e.g., Bachelor of Business Administration degree with a major in Accounting)*.

   Master of Science in Arid Land Studies

3. Proposed CIP Code:
   03.0104.02, Environmental Science

4. Number of Semester Credit Hours Required:
   Required at least 30 hours of credit.

5. Administrative Unit: Identify where the program would fit within the organizational structure of the university (*e.g., The Department of Electrical Engineering within the College of Engineering*).
   The Graduate School

6. Delivery Mode: Identify how and where the program would be delivered, e.g. on-campus face-to-face, online, off-campus, interactive videoconferencing, hybrid, etc.
   Program will be delivered on-campus face-to-face, but it can include off-campus face-to-face classes.

7. Implementation Date: Report the first semester and year that students would enter the program.
   Program is proposed in the 2010 fall semester.

8. Contact Person: Provide contact information for the person who can answer specific questions about the program.
   Name: Dr. Aderbal C. Correa
   Title: Director, International Center for Arid and Semiarid Land Studies
   E-mail: AC.Correa@ttu.edu
   Phone: (806)742-2218 ext. 252

Signature Page

I hereby certify that all of the following criteria have been met in accordance with the procedures outlined in Coordinating Board Rules, Chapter 5, Subchapter C, Section 5.44:

(a) The program has institutional approval.

(b) The program complies with the *Standards for Bachelor's and Master's Programs.*

(c) Adequate funds are available to cover the costs of the new program.

(d) New costs during the first five years of the program will not exceed $2 million.

(e) The program is a non-engineering program (i.e., not classified under CIP code 14).

(f) The program will be offered by a university or health-related institution.

I understand that the Coordinating Board will update the program inventory for the institution if no objections to the proposed program are received during the 30-day public comment period.

_____ _____
Chief Executive Officer Date

I hereby certify that the Board of Regents has approved this program.

Date of Board of Regents approval: _____

_____ _____
Board of Regents (or Designee) Date

New Program Request Form for Bachelor's and Master's Degrees

Directions: An institution shall use this form to propose a new bachelor's or master's degree program. In completing the form, the institution should refer to the document *Standards for Bachelor's and Master's Programs,* which prescribes specific requirements for new degree programs. Note: This form requires signatures of (1) the Chief Executive Officer, certifying adequacy of funding for the new program; (2) a member of the Board of Regents (or designee), certifying Board approval, and (3) if applicable, a member of the Board of Regents or (designee), certifying that criteria have been met for staff-level approval. Note: An institution which does not have preliminary authority for the proposed program shall submit a separate request for preliminary authority. That request shall address criteria set in Coordinating Board rules Section 5.24 (a).

Information: Contact the Division of Academic Affairs and Research at 512/427-6200 for more information.

Administrative Information

1. Institution:
   Texas Tech University

2. Program Name:
   Master of Science in Arid Land Studies (MSALS)

3. Proposed CIP Code:
   03.0104.02, Environmental Science

4. Brief Program Description – *Describe the program and the educational objectives:*
   This is an interdisciplinary program focused on the study of many of the characteristic aspects of arid and semi arid lands. This program is ideally suited to the present and future needs of the arid and semiarid lands of West Texas. Students are required to take classes in at least three different subject areas, such as agricultural science and natural resources, geosciences and water resources. Students should not take more than 12 credit hours in any one area, and no more than 18 credit hours within a single college except Arts and Sciences.

   The program is designed for students with different undergraduate backgrounds in science or engineering that want to acquire the multidisciplinary knowledge that will make them very effective professionals in interdisciplinary teams that work in environmental ("green") jobs for scientists and engineers in Texas and in other arid regions.

5. Administrative Unit – *Identify where program would fit within structure of the university:*
   The Graduate School

6. Proposed Implementation Date – *Report 1st semester and year students would enter program:*
   Year: 2010 Academic Semester: Fall

7. Contact Person – *Provide contact info for person who can answer questions about program:*
   Name: Dr. Aderbal C. Correa
   Title: Director, Intl. Center for Arid and Semiarid Studies (ICASALS)
   E-mail: AC.Correa@ttu.edu
   Phone: (806) 742-2218 X252

Program Information

I. Need

A. Job Market Need

Since the global economy was shocked by recession in 2008, the meaning of "sustainability" in the economy and in other areas, such as natural resources availability and environmental protection, has become more significant. The threat of environmental destruction, particularly the threat of exhaustion of water resources in the drylands of the American Southwest (including West Texas), and the increasing expectations that climate changes will become irreversible or permanent, raises new questions about our ability to cope with change. Will we have the resources—human, technological and economic—to deal with these issues? The new graduate program will be part of Texas Tech's mission in education and service to train students and retool professionals who want to acquire knowledge that will contribute effectively to the work of government and private organizations' in the drylands of Texas, the nation, and abroad.

The Arid Land Studies graduate program will promote research in many of the university's strategic areas as part of the sustainable society initiative. The interdisciplinary characteristic of this program, integrating agricultural sciences and natural resources, geosciences, and water resources, will support research and education in diverse areas, such as sustainable agriculture and management, environmental and ecosystem management, environmental biology, water resource development, environmental and natural resource economics, remote sensing and geospatial analysis, and others.

1. Short term needs

It has been reported that an impressive $40 billion of President Obama's $787 billion stimulus package, will be spent on the creation of jobs that have a positive impact on the environment ("green jobs"). This report should come as great news to job seekers. Many are getting on board for a green career. Some facts to be considered:

- Opportunities for green careers can be found and are growing in the state of Texas and across the nation;
- Contrary to popular belief, "green jobs" are not just for scientists and PhDs;
- Many traditional jobs are being given a "green" makeover;
- Building and manufacturing are popular sectors, but "green jobs" also include retail, science, and agriculture. West Texas, as an agricultural center, is an ideal place for such jobs.

The US is currently seeing an expansion of two-year college programs focusing on "green" careers, states Alice Ramey, economist in the Office of Occupational Statistics and Employment Projections, Bureau of Labor Statistics. Many students are betting on a boom in the green-collar job industry—careers they can train for without a four-year degree or with an appropriate Master's degree if they graduate with traditional science or engineering degrees.

The Texas Workforce Commission employment data for 2006 and statistical projections for 2016 in reference to occupations that could be filled by Master of Science graduates in Arid Land Studies are shown in Table 1.

OCCUPATION	Employed 2006	Projected 2016	% Change	Annual Avg. Openings
Conservation Scientists	800	950	18.8	40
Environmental Engineering Technicians	1,550	1,900	22.6	65
Environmental Science and Protection Technicians	3,650	4,300	17.8	210
Environmental Scientists and Specialists	4,600	5,900	28.3	250
Environmental Science Teachers, Postsecondary	150	200	33.3	5
Forest and Conservation Technicians	250	250	0.0	15
Geography Teachers, Postsecondary	200	300	50.0	15

Table 1. Most recent Texas Workforce Commission employment data (2006) and projections for 2016, for selected occupations in environmental conservation and protection areas (http://www.tracer2.com).

2. <u>Long term needs</u>
   The long term needs relate to the need to apply policy decisions and to develop strategies to better use, manage and protect the resources in West Texas. The water of the Ogallala Aquifer provides an excellent example of the long term need for scientists, researchers and practitioners who can extend the life of this resource.

   Employment information collected by the Bureau of Labor Statistics (BLS) summarized in the charts below for environmental scientists and specialists, including health (Fig. 1) and conservation scientists (Fig. 2), show the employment situation by industry for May 2008.

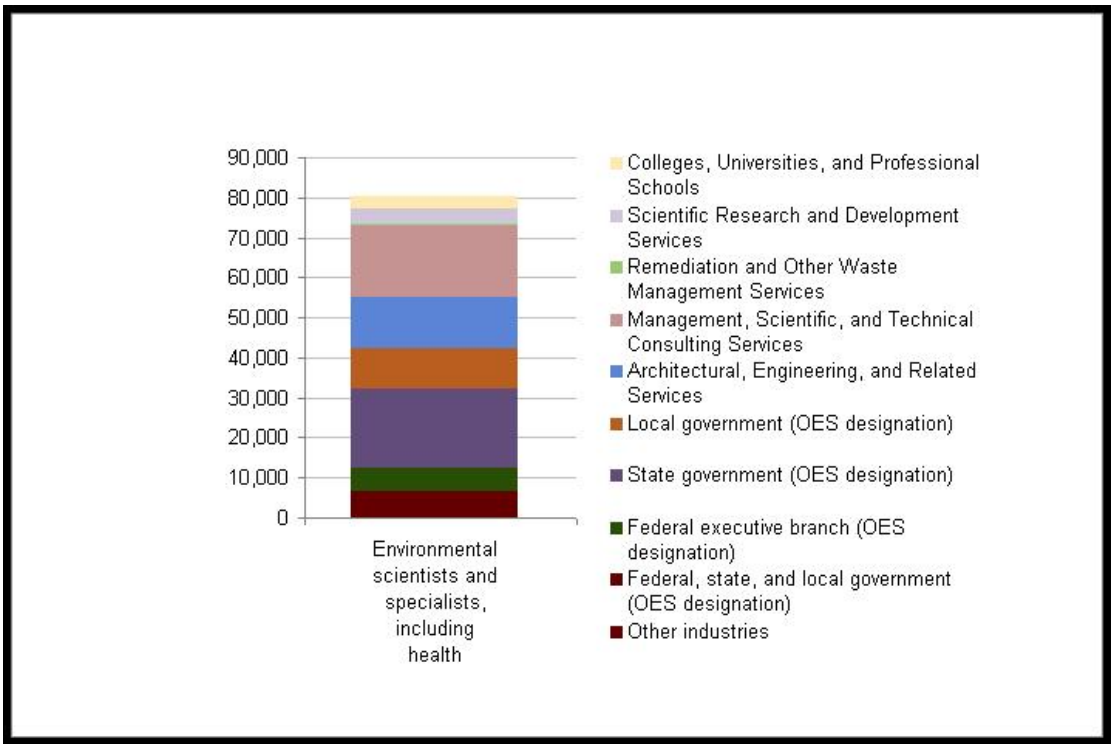

Fig. 1. Employment of environmental scientists by industry (May 2008, modified from BLS).

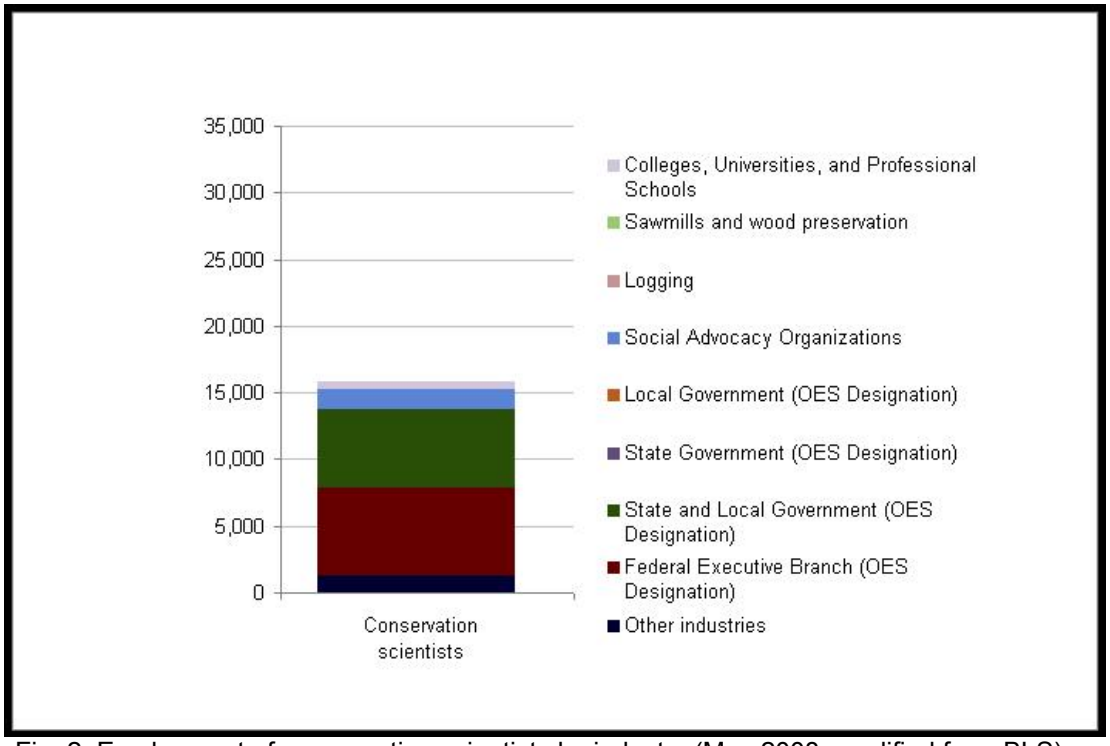

Fig. 2. Employment of conservation scientists by industry (May 2008, modified from BLS).

Academia (colleges, universities and professional schools), social advocacy organizations, federal, state and local governments are among the largest employers for environmental scientists and specialists (Charts 1 and 2, 2008 data). The federal government was one of the highest paying employers for conservation scientists, and the state government was among the highest paying employers for environmental scientists. It is noteworthy that while California provides the highest employment for all types of environment-related occupations, **Texas and Florida employed the highest number of environmental science and environmental engineering** (not specified on charts) **occupations.** Therefore, it is projected that the Master of Science in Arid Land Studies will enhance the development of small businesses in West Texas.

Contacts made in November 2009 with potential employers of Arid Land Studies graduates in West Texas produced the results recorded below:

- Canadian River Municipal Water Authority hires an average of 2 scientists/specialists per year (Ms. *Tammy Hamby, Sanford*).
- High Plains Underground Water District No. 1 employs 1 new field technician per year (Ms. *Sherry Stevens, Lubbock).*
- Texas Commission on Environmental Quality (current consolidation of most state water/natural resource-related agencies) experiences a yearly 8% turnover of staff and hires an average of 170 environmental specialists per year, statewide *(Melissa Applegate, Austin).*

B. Student Demand

The University of Arizona is the only US institution with a graduate program similar to the one being created at Texas Tech. The Arid Lands Resource Sciences (ALRS) interdisciplinary program at the University of Arizona leads to the Doctor of Philosophy in ALRS. The ALRS program was designed to serve both students progressing from undergraduate to graduate education and non-traditional students who may have degrees in engineering, agronomy and other areas that would bring real-world experience to their graduate studies. Since its inception in 1972, the ALRS program has attracted a high proportion of students from other countries, comprising, on average, 25% of the student body. Currently, international students in the program are from 14 different countries and six continents. Each year, the ALRS student body consists of approximately 30 students, with an even number of men and women represented.

Thus far, Arid Land Studies at Texas Tech has been offered through the Graduate School as part of a Master's Degree Program in Interdisciplinary Studies. The graduation figures recorded by the Graduate School (Table 2) pertain to all program options, including the Arid Land Studies track. It is

assumed that no more than 5-10% (1 to 2 graduates per year) graduated from the Arid Land Studies track.

Year	# Graduates	Year	# Graduates
1999	28	2005	31
2000	22	2006	24
2001	19	2007	25
2002	25	2008	24
2003	34	2009	17
2004	38	Total | Avg.	287 | 26

Table 2. Number of students that completed the Interdisciplinary Master's program from TTU's Graduate School.

Drawing on the data from the University of Arizona and from Texas Tech's own Graduate School statistics, the student demand for Texas Tech's Master of Science in Arid Land Studies can be expected to increase gradually to an average annual enrollment of at least 20 students. The national and global concerns about climate change, environmental issues, and freshwater water supply should increase the demand for specialists in this area. Locally, the agricultural, industrial, and urban consumption of water from the Ogallala Aquifer is likely to create employment opportunities for specialists in arid land issues. Details on the projections for the first five years follow.

C. Enrollment Projections – The estimated cumulative headcount and full-time student equivalent (FTSE) enrollment for the first five years of the program are provided below.

The institution has calculated enrollment projections that reflect student demand estimates, to ensure financial self-sufficiency by the end of the program's fifth year. In calculating yearly FTSE, 24 SCH equals 1 FTSE for master's programs. In accordance with the institution's Uniform Recruitment and Retention Strategy, the institution has developed a plan to recruit, retain, and graduate students from underrepresented groups for the program. Texas Tech's Equal Opportunity Policy states that the institution "*is open to all persons eligible for admission as students regardless of race, color, religion, sex, age, national origin, mental or physical disability, or Vietnam Era or Special Disabled Veteran status. All students admitted to the university are treated without discrimination in regard to their participation in university educational programs or activities*. *The university does not discriminate on the basis of sex or disability in its educational programs*" (Texas Tech University Catalog, 2009-2010).

The Arid Land Studies graduate program will target highly qualified students, particularly those belonging to underrepresented groups in

science and engineering (recruitment outlined p.14). In cooperation with the Graduate School, Arid Land Studies will use the Graduate School's established network with Historical Black Colleges and Universities (HBCU) and Hispanic Serving Institutions (HSI) to identify qualified students.

Table 3 shows a modest estimate of the number of students expected to enroll for the new Master's Degree in Arid Land Studies. The enrollment estimates account for 6 program-subsidized students added per year (funding from current Department of Education grant) during the first 4 years, with at least 2 additional students per year joining the program through internal recruitment. As a result of the external recruitment efforts described on p.14, student interest from West Texas and nearby regions will only increase enrollment not only during the first 5 years, but in the future.

YEAR	1	2	3	4	5
Headcount	8	16	16	16	8
FTSE	6	12	12	12	6

Table 3. Estimate of the number of students registered in the Arid Land Studies Program during the first 5 years.

II. Quality

A. Degree Requirements

The table below shows the degree requirements of the program.

Category	Semester Credit Hours (SCH)	Clock Hours
General Education Core Curriculum *(bachelor's degree only)*	N.A.	
Core Courses	9	
Prescribed Electives	18	
Additional Electives	0-9	
Other: Thesis option	6	
TOTAL	33-36	

The Master of Science degree program in Arid Land Studies is intended for students who wish to continue education at the graduate level, but do not seek specialized training concentrated in a major area. This degree program requires that work be taken in at least three different subject

areas and that no more than 12 hours be presented in any one area. Also, no more than 18 hours may be taken within a single college, except Arts and Sciences. Students might pursue the thesis option (24 hours of graduate coursework plus 6 hours of thesis [6000]), which is appropriate when the student's previous work seems to qualify him or her for research. The 36-hour non-thesis plan is also available, and students may choose either the master's examination or the portfolio as their terminal project.

Initially, a student will take thesis hours in the department of his/her faculty advisor. In the future, Arid Land Studies (ALS) course listings will be made available for both thesis hours and other ALS-specific curriculum. Examples of other courses to be proposed for the program may include, but are not limited to a cumulative capstone class, ALS management strategies, and/or ALS research methods.

B. Curriculum

The core curriculum of the Arid Land Studies program consists of three Core courses (i.e. 9 SCHs). Additionally, students must take 6 Prescribed Elective courses (18 SCHs) selected from a list including Agricultural Science and Natural Resources, Physical Sciences, Water Resources, and other study areas. Students pursuing the thesis option will take 6 hours of thesis credit to complete their program curricula. Students pursuing the non-thesis option must take 3 Additional Elective courses (9 SCHs). For the 36 hour non-thesis option, students may choose either the Master's examination or the portfolio as their terminal project.

No new courses are being created for the Arid Land Studies program. The required Core courses are offered regularly by the Department of Civil & Environmental Engineering in the Whitacre College of Engineering, Geography Program in the College of Arts and Sciences, and Department of Natural Resources Management in the College of Agricultural Sciences and Natural Resources. The Prescribed and Additional Elective courses are regularly offered by different academic departments at Texas Tech University.

Students in the Arid Land Studies program will not take any courses as a cohort. It is unlikely that more than a few students will be added to each course's normal enrollment projections in a given year.

Number of hours in degree program

The number of semester credit hours (SCHs) for the degree is comparable to the number the SCHs required for similar degrees in the state. A minimum number of 30 SCHs are required to complete a Master's program degree. The Arid Land Studies Master's program requires 30 to 36 SCHs.

Core Courses

The Master of Science degree in Arid Land Studies has three required Core courses that are offered regularly by the Department of Civil & Environmental Engineering in the Whitacre College of Engineering, Geography Program in the College of Arts and Sciences, and Department of Natural Resources Management in the College of Agricultural Sciences and Natural Resources.

These courses have been selected because they provide students from different undergraduate backgrounds with a basic core of knowledge. They provide an overview of arid lands in the world and their common characteristics (GEOG 5306) and acquaint students with management of watersheds and water resources, which is critical to those regions (CE 5366 and NRM 5317).

Prefix and Number	Core Courses	SCH
CE 5366	Water Resources Management	3
GEOG 5306	Seminar in Geography of Arid Lands	3
NRM 5317	Watershed Management	3

Prescribed Elective Courses

The Master of Science degree in Arid Land Studies has a list of courses in different areas that complement those required from all students. The Prescribed Elective courses are numerous enough to provide training in diverse areas of interest and provide students with a desirable breadth and depth of knowledge.

The Prescribed Elective courses are in the areas of Agricultural Sciences and Natural Resources, Civil Engineering, Geosciences, Water Resources, Biology, and Environmental Toxicology. The curriculum is necessarily flexible and creates options for students to identify those areas where they will focus their future professional activities or pursue advanced graduate research.

In order to meet the requirements of an interdisciplinary program, a student coming into the new Arid Land Studies program with an undergraduate degree in Civil Engineering, for instance, must take graduate courses in other areas, such as Agricultural Sciences, Geosciences, or other areas of interest.

A list of Prescribed Elective courses is provided below, and syllabi for Core and Elective Courses are included in Appendix A.

Prefix and Number	Prescribed Elective Courses	SCH
AAEC 5314	Environmental Economics and Policy Analysis	3
AGSC 5303	Ecology and Grazing Lands Systems	3
ATMO 5302	Weather, Climate and Applications	3
BIOL 5330	Advanced Landscape Ecology	3
CE 5361	Surface Water Hydrology	3
CE 5363	Groundwater Hydrology	3
CE 5364	Groundwater Transport Phenomena	3
CE 5394	Natural Systems for Wastewater Treatment	3
ENTX 6361	Environmental and Wildlife Toxicology	3
ENTX 6371	Procedure and Techniques in Ecological Risk Assessment	3
GEOG 5300	Geographic Information Systems	3
GEOG 5301	Remote Sensing of the Environment	3
GEOG 5302	Advanced Geographic Information Systems	3
GEOG 5309	Seminar in Regional Analysis	3
GEOL 5341	Digital Imagery in Geosciences	3
GEOL 5342	Spatial Data Analysis and Modeling in Geosciences	3
NRM 5310	Advanced Range Ecology	3
NRM 5322	Advance Nongame Ecology and Management	3
NRM 5404	Aerial Terrain Analysis	3
NRM 6303	Imagery Interpretation for Natural Resource Management	3
NRM 6305	Geospatial Technologies in Natural Resource Management	3
PSS 5329	Precision Agriculture	3
PSS 5333	Soil and Plant Relationships	3
PSS 5334	Soils and Crops in Arid Lands	3

<u>Additional Electives</u>
Additional Elective courses can be taken in Agricultural Science and Natural Resources, Physical Sciences, Water Resources, and other study areas. These Additional Elective courses must be approved by the program faculty advisor.

C. Faculty

The tables below provide information about Core and Support faculty. An asterisk (*) is placed before the name of the individual who will have direct administrative responsibilities for the program. Dr. Correa will administer the program 50% of his time.

Name of Core Faculty and Faculty Rank	Highest Degree and Awarding Institution	Courses Assigned in Program	% Time Assigned To Program
*Correa, Aderbal C. Director, Intl. Ctr. Arid and Semiarid Land Studies, Coord. M.S. Arid Land Studies and International Dev. and Adjunct Professor	Ph.D., Stanford U.		50%
Fish, Ernest B. Professor	Ph.D., U. Arizona	NRM 5317, 5404, 6303, 6305	0%
Lee, Jeffrey A. Professor	Ph.D., Arizona State U.	GEOG5306	0%
Rainwater, Kenneth Professor	Ph.D., U. Texas	CE 5366	0%

Name of Support Faculty and Faculty Rank	Highest Degree and Awarding Institution	Courses Assigned in Program	% Time Assigned To Program
Allen, Vivian Thornton Chair and Horn Professor	Ph.D., Louisiana State U.	AGSC 5303	0%
Boal, Clint Research Associate Professor	Ph.D., U. Arizona	NRM 5322	0%
Bronson, Kevin F. Associate Professor	Ph.D., Auburn U.	PSS 5334	0%
Carter, Perry Associate Professor	Ph.D., Ohio State U.	GEOG 5309	0%
Cleveland, Ted C. Associate Professor	Ph.D., U. California, Los Angeles	CE 5361	0%
Cox, Robert D. Assistant Professor	Ph.D., U. California-Riverside	NRM 5310	0%
Delahunty, Tina Assistant Professor	Ph.D., Humboldt State U.	GEOG 5301	0%
Fedler, Clifford B. Professor	Ph.D., U. Illinois	CE 5394	0%
Johnson, Jeff Assistant Professor	Ph.D., Texas Tech U.	AAEC 5314	0%
Lascano, Robert J. Assistant Professor	Ph.D., Texas A&M U.	PSS 5333	0%

Leary, Colleen Ann Professor	Ph.D., U. Washington	ATMO 5302	0%
Leverington, David Assistant Professor	Ph.D., U. Manitoba-Winnipeg	GEOL 5341	0%
Maas, Stephan J. Professor	Ph.D., Texas A&M U.	PSS 5329	0%
McIntyre, Nancy E. Associate Professor	Ph.D., Colorado State	BIOL 5330	0%
Mulligan, Kevin Associate Professor	Ph.D., Texas A&M U.	GEOG 5300, 5301, 5302	0%
Nagihara, Seiichi Associate Professor	Ph.D., U. Texas	GEOL 5442	0%
Smith, Philip N. Associate Professor	Ph.D., Texas Tech U.	ENTX 6361, 6371	0%

All Core and Support faculty involved in the Master of Science degree in Arid Land Studies have terminal degrees from institutions that are accredited by agencies recognized by the Coordinating Board or from equivalent institutions located outside the United States. Curriculum Vitae for Core and Support Faculty are included in Appendix B. Additional Faculty Roster Forms are included in Appendix F.

D. Students

Recruitment. The program will follow the institution's Uniform Recruitment and Retention Strategy, and, in addition, the administrator of the program will travel to conferences organized by the HBCU and HSI organizations to present and solicit partnerships to develop a stream of students for the program. Among possible HBCU locations, Prairie View A&M University, Texas Southern University, Wiley College, and/or others will be included in a Texas recruitment campaign. Among HSIs, the University of Texas-Pan American, University of Texas-El Paso, Texas A&M-Kingsville, and/or others will be included in a similar effort.

Student recruitment to the program will be carried out through established channels of communication including, brochures, posters, websites, information sessions, and individual meetings. The new Master's program in Arid Land Studies will have a program website, hosted by TTU, which will provide public access to its distinctive features in order to attract new students. Program evaluations will be used by the project coordinator to improve the program and recruitment methods.

Student recruitment for the program will target highly qualified students, particularly those belonging to underrepresented groups in science and engineering. This will be achieved through the distribution of promotional materials in both English and Spanish. Additionally, students from

underrepresented populations within the program will receive information promoting the pursuit of advanced degrees and guidance towards internship opportunities and employment in industry, government and non-government organizations.

Admission. The Graduate School has three general categories of admission criteria:

1. Academic records
2. Test scores on the General Test of the Graduate Record Examination (GRE) no more than five years old. International students must submit official scores on the TOEFL (Test of English as a Foreign Language) or IELTS (International English Language Testing Service) at or above minimum scores accepted by Texas Tech.
3. Individual profiles including recommendations, research background, motivation, multilingual proficiency, undergraduate institution, presentations, interviews, work experience, community involvement, family and socioeconomic background, and demonstrated commitment to this field of study. Additional requirements and a separate application form may be required for particular programs.

E. Library

Existing library resources at TTU will be adequate to support the program. Faculty and library staff will collaborate on writing a collection development policy for the program and on purchasing core collection materials. TTU library resources are detailed in Table 4.

Subject Area	Books	Print Journals	Digital Journals	E-books/ Internet Sources	Visual Aids & Maps	Sound	Archival/ Digital Data
Agricultural Sciences	29605	2983	20	41	4	2	1
Amospheric Sciences	442	25	4	6/13	1/7	1	6
Biological Sciences	12410	50	253	343	0/1305	0	2
Civil Engineering	1816	191	22	9/9	12/1	6	5/3
Environmental Toxicology	1272	96	7	55/37	0	5	5
Geography	6634	241	38	111/13	47/520	6	26
Geology	11386	803	53	38/204	9/1681	10	10/34
Natural Resource Management	916	19	27	14	1/16	1	1
Plant Sciences	584	48	17	5	5	1	
Soil Sciences	649	52	11	35	1	1	1

Table 4. Texas Tech University Library resources available for the Arid Land Studies Program.

There is a seperate collection for Environmental Toxicology at the Institute of Environmental and Human Health, located at the campus of the Reese Technology Center (http://www.tiehh.ttu.edu/).

Databases in Environmental and Arid Land Studies: The library has 22 databases in the area of environmental toxicology and 18 databases in the area of geography.

Services beneficial to graduate students: The library offers services that facilitate access to, use of, and dissemination of scholarly information to targeted audiences to the entire university and Lubbock community. Such services include a personal subject librarian, with background in the subject areas to work with graduate students as a class or on one-to-one basis to meet their research needs. The library holds workshops, seminars, and database demo sessions all year round, and it also works with faculty members to customize services to meet the needs of specific graduate students.

The TTU Library has consortia agreements within the world wide library network, so what the TTU libraries do not have can be obtained with a fast turnaround time through the interlibrary loan process.

F. Facilities and Equipment

The Master of Science degree in Arid Land Studies involves courses that are being taught at several academic Departments at Texas Tech, each of which provides the infrastructure (facilities and equipment) needed for involved courses. Facilities and equipment will be equivalent to those provided at similar programs in the state and nation.

G. Accreditation

There is no national accrediting body for the interdisciplinary area of interest.

H. Evaluation

Student Evaluation. The Graduate School requires a final comprehensive evaluation for all students in this program. Because each student will have a distinct set of courses, the final evaluation will be conducted by faculty from the student's areas of concentration and will focus on those areas. The comprehensive evaluation is most often administered in the semester of intended graduation. The evaluation format may differ for thesis and nonthesis options. The final evaluation should require a synthesis and application of knowledge acquired during the course of study and research leading to the master's degree; no student should expect the evaluation to be based solely on performance in the classroom.

A student is eligible to undergo evaluation only after having been admitted to candidacy by the graduate dean. As soon as possible after the evaluation, a written report of the outcome should be sent to the graduate dean. A student who does not receive a satisfactory evaluation may be assessed once again after an interval of at least three months. At the discretion of the program concerned, a student who receives a satisfactory evaluation but who does not graduate within 12 months may be required to repeat the assessment.

The final assessment of a student's knowledge and abilities is provided by his/her thesis. An approved thesis acknowledges that the student correctly analyzed and interpreted research data. Students who do not take the thesis option must submit a reflective statement and a portfolio of accumulated and revised research. A portfolio or thesis, depending on the degree track of the individual student, must reflect integration of the three Core fields in the ALS curriculum. Students, as a result, will not be asked to demonstrate mastery of these subjects individually, but rather will demonstrate a synthesized understanding of connections among the fields, making interdisciplinary research and application of the utmost importance. Approval of these documents represents the individual's mastery of data analysis and interpretation.

Upon completion of the program, students will be asked to take an exit survey rating the effectiveness of the program. This survey form will be modeled after the "Post-Graduate Survey" used by TTU's Office of Institutional Research and Information Management (http://surveys.irim.ttu.edu/cgi-bin/qwebcorporate.cgi). Program administrators will strongly encourage students to maintain contact following graduation, as a means of tracking student/program success.

Program Evaluation. Learning Objectives and Outcomes for the program as a whole can be measured in full using the final comprehensive evaluation instruments discussed above. The Methods of Assessment of these outcomes and the faculty evaluation sheets by which student performance is measured (entitled, "Rubric for Outcomes Assessment of Student Learning") are attached in Appendix C. Program Learning Objectives and Outcomes require that:

1) Students will be able to demonstrate their advanced knowledge in three or more different fields of study.
2) Students will be able to integrate three or more fields of study.
3) Students will demonstrate mastery of written communication.
4) Students will demonstrate effective oral communication.
5) Students will demonstrate the ability to think critically on issues related to their chosen fields of study.

As a pre-evaluation of the program, the above statements are mapped to each of the Required Courses of the Arid Land Studies curriculum in Table 5. This Table summarizes the level of content delivery for each course and feedback on student performance/assessment, with relation to the objectives set forth here.

LEGEND

[i] OUTCOME STATEMENT:

The program outcome is (e) EXPLICITLY (score of 2) or (m) IMPLICITLY (score of 1) reflected in the course syllabus as being one of the learning outcomes for this course.

[ii] LEVEL OF CONTENT DELIVERY:

(I) INTRODUCED - Students are not expected to be familiar with the content or skill at the collegiate level. Instruction and learning activities focus on basic knowledge, skills, and/or competencies and entry-level complexity. Only one (or a few) aspect of a complex program outcome is addressed in the given course (score of 1).

(R) REINFORCED- Students are expected to possess a basic level of knowledge and familiarity with the content or skills at the collegiate level. Instruction and learning activities concentrate on enhancing and strengthening knowledge, skills, and expanding complexity. Several aspects of the program outcome are in the given course, but these aspects are treated separately (score of 2).

(A) ADVANCED - Students are expected to possess a strong foundation in the knowledge, skill, or competency at the collegiate level. Instructional and learning activities continue to build upon previous competencies with increased complexity. All components of the outcome are addressed in the integrative contexts (score of 3).

[iii] FEEDBACK ON STUDENT PERFORMANCE / ASSESSMENT:

(F) Students are asked to demonstrate their learning on the outcome through homework, projects, tests, etc. and are provided formal Feedback (score of 1).

Texas Tech University Program Level - Curriculum Map

Date	3/12/2010	SELECTED *PROGRAM LEARNING OUTCOMES*																
Degree Title: Arid Land Studies		1) Students will be able to demonstrate their advanced knowledge in three or more different fields of study.			2) Students will be able to integrate three or more fields of study.			3) Students will demonstrate mastery of written communication.			4) Students will demonstrate effective oral communication.			5) Students will demonstrate the ability to think critically on issues related to their chosen fields of study.				
MS in Interdisciplinary Studies, Graduate School																		
Courses in Degree Program		[i] Outcome Statement (X, M)	[ii] Level (I, R, A)	[iii] Feedback (F)	[i] Outcome Statement (X, M)	[ii] Level (I, R, A)	[iii] Feedback (F)	[i] Outcome Statement (X, M)	[ii] Level (I, R, A)	[iii] Feedback (F)	[i] Outcome Statement (X, M)	[ii] Level (I, R, A)	[iii] Feedback (F)	[i] Outcome Statement (X, M)	[ii] Level (I, R, A)	[iii] Feedback (F)		
CE 5366		M	I	F	X	R	F	M	A	F	M	A	F	X	A	F		
GEOG 5306		M	I	F	M	R	F	X	A	F	X	A	F	X	A	F		
NRM 5317		M	I	F	M	R	F	M	A	F	M	A	F	X	A	F		

Table 5. Objectives and Outcomes Map for required courses in Master of Science in Arid Land Studies.

External Evaluation. During the first four years in the establishment of the program, the Master of Science Degree in Arid Land Studies will draw support from the US Department of Education's Fund for the Improvement of Postsecondary Education (FIPSE), specifically the EU-US Atlantis Program. This funding supports an external evaluator, who will collect and analyze information about program activities, characteristics of the program at partner institutions, and observed outcomes, and will provide feedback to the program coordinator. Dr. James McCartney, Professor *Emeritus* of Sociology and the former Director of the International Center and Interim Associate Vice Provost for International Programs at the University of Missouri-Columbia will serve in this role. The information collected by the evaluator will consist of (1) quotations from people, (2) direct observations, and (3) written documents (Patton, 1997). It will be

crucial to acquire information about the circumstances surrounding a student's withdrawal from the program, should that occur. This knowledge and the understanding of the organization and academic aspects of the project will contribute to making program adjustments for the largest impact on student success. Ultimately, the evaluation will guide the implementation of a program that will be a source of pride for Texas Tech University and a model for similar initiatives.

Additionally, the program will receive an annual Classification of Institutional Programs (CIP) review through the TTU Graduate School, ensuring program quality and effectiveness past the term of the FIPSE funding and of its external evaluator.

III. Costs and Funding

Five-Year Costs and Funding Sources – Table 6 shows five-year costs for the program. The majority of funding is available from a grant of the Department of Education FIPSE EU-US Atlantis Program, PI is Dr. A.C. Correa. This budget is detailed on a yearly basis in Appendix D. The subsequent Appendix E specifies expenditures that will be drawn from federal funds.

Five-Year Costs		Five-Year Funding	
Personnel[1] : A.C. Correa	$24,203	Reallocated Funds	$0
Facilities and Equipment	$0	Anticipated New Formula Funding[3]	$18,897
Library and Supplies	$660	Special Item Funding	$0
Other[2] : Collaborating faculty stipend for travel	$60,000	Other[4]: US Dept. Education Grant for student scholarships.	$420,000
Total Costs	**$84,863**	**Total Funding**	**$438,897**

Table 6. Costs and funding for a 5-year time period.

1. Cost for Program Administrator (existing faculty member) to coordinate the program. This salary portion is drawn from federal funding through the US Department of Education.
2. Funding provided by Dept. of Education grant to support travel by faculty advisors and/or thesis committee members.
3. The Master's Degree in Arid Land Studies Program does not offer any courses at the Graduate School; therefore there is no provision to benefit from Formula Funding. All students will be enrolled in courses regularly offered by different Departments; therefore the estimate amount from formula funding will be distributed to those Departments. Most of the courses taken by MSALS students are likely to be in Science, Agriculture, and Engineering (i.e. Formula Codes 02, 05 and 06 and respective Formulas for Masters: 8.09, 7.07 and 7.63), The average formula weight for Masters students taking courses in these three areas in these areas is $472.43 (TTU Formula Funding Codes and Rates, FY 2010-2011, Weight = $62.19). In terms of Responsibility Center Management, this estimation of formula funding means increased earnings to Departments offering courses to MSALS students in addition to the disciplinary student population. In financial terms, the formula from the program is "found money" (free earnings to support increase and expansion). This estimation indicates the future growing benefit that the program delivers as it matures.
4. In-hand, federal funding to support students. Under the conditions of this funding, regular tuition and fees will be paid to the university.

Signature Page

1. Adequacy of Funding – The chief executive officer shall sign the following statement:

   I certify that the institution has adequate funds to cover the costs of the new program. Furthermore, the new program will not reduce the effectiveness or quality of existing programs at the institution.

   _____

   Chief Executive Officer Date

2. Board of Regents or Designee Approval – A member of the Board of Regents or designee shall sign the following statement:

   On behalf of the Board of Regents, I approve the program.

   _____

   Board of Regents (Designee) Date of Approval

3. Board of Regents Certification of Criteria for Commissioner of Assistant Commissioner Approval – For a program to be approved by the Commissioner or the Assistant Commissioner for Academic Affairs and Research, the Board of Regents or designee must certify that the new program meets the eight criteria under TAC Section 5.50 (b): The criteria stipulate that the program shall:

   (1) be within the institution's current Table of Programs;
   (2) have a curriculum, faculty, resources, support services, and other components of a degree program that are comparable to those of high quality programs in the same or similar disciplines at other institutions;
   (3) have sufficient clinical or in-service sites, if applicable, to support the program;
   (4) be consistent with the standards of the Commission of Colleges of the Southern Association of Colleges and Schools and, if applicable, with the standards or discipline-specific accrediting agencies and licensing agencies;
   (5) attract students on a long-term basis and produce graduates who would have opportunities for employment; or the program is appropriate for the development of a well-rounded array of basic baccalaureate degree programs at the institution;
   (6) not unnecessarily duplicate existing programs at other institutions;
   (7) not be dependent on future Special Item funding
   (8) have new five-year costs that would not exceed $2 million.

   On behalf of the Board of Regents, I certify that the new program meets the criteria specified under TAC Section 5.50 (b).

   _____

   Board of Regents (Designee) Date

Appendix A:
MATRIX OF COURSES AND COURSE SYLLABI

Core Courses	**Theme**	**Page**	**Instructor CV**	**Page**
CE 5366 Water Resources Management	DW	23	Dr. Ken Rainwater	84
GEOG 5306 Seminar in Geography of Arid Lands	DE	24	Dr. Jeff Lee	78
NRM 5317 Watershed Management	DD	25	Dr. Ernest Fish	75
Prescribed Elective Courses				
AAEC 5314 Environmental Economics and Policy Analysis	DD	27	Dr. Jeff Johnson	75
AGSC 5303 Ecology of Grazing Lands Systems	DE	29	Dr. Vivian Allen	66
ATMO 5302 Weather, Climate, and Applications	DE	31	Dr. Colleen Ann Leary	77
BIOL 5330 Advanced Landscape Ecology	DE	33	Dr. Nancy E. McIntyre	81
CE 5361 Surface Water Hydrology	DW	34	Dr. Ted Cleveland	70
CE 5363 Groundwater Hydrology	DW	35	Dr. Ken Rainwater	84
CE 5364 Groundwater Transport Phenomena	DW	37	Dr. Ken Rainwater	84
CE 5394 Natural Systems for Wastewater Treatment	DW	38	Dr. Clifford B. Fedler	73
ENTX 6361 Environmental and Wildlife Toxicology	DE	40	Dr. Phil Smith	85
ENTX 6371 Procedure & Techniques in Ecological Risk Assessment	DE	42	Dr. Phil Smith	85
GEOG 5300 Geographic Information Systems	DA	44	Dr. Kevin Mulligan	82
GEOG 5301 Remote Sensing of the Environment	DA	46	Dr. Tina Delahunty	72
GEOG 5302 Advanced Geographic Information Systems	DA	47	Dr. Kevin Mulligan	82
GEOG 5309 Seminar in Regional Analysis	DD	48	Dr. Perry Carter	69
GEOL 5341 Digital Imagery in Geosciences	DA	51	Dr. David Leverington	79
GEOL 5342 Spatial Data Analysis and Modeling in Geosciences	DA	52	Dr. Seiichi Nagihara	83
NRM 5310 Advanced Range Ecology	DE	53	Dr. Robert D. Cox	71
NRM 5322 Advance Nongame Ecology and Management	DE	54	Dr. Clint Boal	67
NRM 5404 Aerial Terrain Analysis	DA	56	Dr. Ernest Fish	74
NRM 6303 Imagery Interpretation for NRM	DD	58	Dr. Ernest Fish	74
NRM 6305 Geospatial Technologies in NRM	DA	60	Dr. Ernest Fish	74
PSS 5329 Precision Agriculture	DP	61	Dr. Stephen Maas	80
PSS 5333 Soil and Plant Relationships	DP	62	Dr. Robert Lascano	76
PSS 5334 Soils and Crops in Arid Lands	DP	64	Dr. Kevin Bronson	68

"Theme" Legend
DA = Natural Resource Data Analysis
DD = Dryland Economy and Development
DE = Ecology and Environmental Science
DP = Dryland Agriculture
DW = Water Resource Management

MAJOR TOPIC: Water Resources and Environmental Technology

CE 5366 WATER RESOURCES MANAGEMENT (3 credit hours) **REQUIRED COURSE**

Faculty Information:

Dr. Ken Rainwater Office CIV 203D ken.rainwater@ttu.edu

Course Information:

- **Prerequisites:** Consent of Instructor
- **Required Text**: *Principles of Surface Water Quality Modeling and Control*, Thomann and Mueller, and other readings as assigned.

Course Description and Purpose:

Models and other technical elements of water resources systems in context of the political, social, and other environments in which they exist.

Course Outline:

Week	Text Source	Topics and **Events**
1	T&M 1	Introduction to Water Quality Modeling
2	2	Rivers and Streams
3		
4	6	Dissolved Oxygen
5		
6	3	Estuaries, Bays, and Harbors
7	4	Lakes, **First Review Due**
8		**Exam 1**
9	Readings	Engineering Economy
10		Spring Break
11	Readings	Decision Analysis
12		
13		Surface Water Reservoirs
14		Flood Mitigation, Water Supply
15		Water Resources Development and Policy
16		**Second Review Due**
17		Review

Expected Learning Outcomes:

The student will be trained in the modeling the processes and parameters that determine the fate of man-made discharges on surface water quality. The student will understand the major technical and non-technical considerations required in providing adequate planning and management of water resources projects. The course supports both the environmental and water resources specialty areas.

Criteria for Grading:

1. Homework – Several homeworks will be distributed through the semester, usually with one week to complete each assignment. After the graded homeworks are returned the solutions will be posted. Use of spreadsheets is encouraged for repetitive tabular calculations and graphs, but sample calculations are required for full credit. Each student must submit his/her own spreadsheet.
2. Article reviews – Two brief (3-5 pages, typed, double-spaced) reviews of articles from the professional literature will be required during the semester.
3. Exams – Two exams will be given. The final exam will only cover the material after Exam 1. No make-up exams will be given for simple absence. Both exams will be scheduled for 2.5 hr.
4. Class conduct – Students are expected to treat each other and the instructor respectfully. All students are expected to observe appropriate personal hygiene practices.

Grading Policy

Homework 30% Article reviews 20% Exams 50% Total: 100%

Class Attendance: Required

MAJOR TOPIC: Earth Sciences

GEOG 5306 SEMINAR IN GEOGRAPHY OF ARID LANDS (3 credit hours) REQUIRED COURSE

Faculty Information:

Name: Dr. Jeff Lee Office: Holden Hall 209A Email: jeff.lee@ttu.edu

Course Information:

- **Prerequisites:** Consent of Instructor
- **Required Text:** There is no required textbook. Readings will be assigned during the semester and students will choose a book to read.

Course Description and Purpose:

This course deals with the arid and semi-arid regions of the world. We will explore these lands through a combination of relevant topics and regional studies. While the main focus will be on the scientific aspects of the environments, humanistic approaches to the study of arid lands will be part of the course as well. The graduate and undergraduate courses will be taught together and will be organized partly as a lecture course and partly as a seminar.

Course Outline:

Introduction; Defining Arid Lands
Climate
Landscapes
Plants and Animals
agriculture and water resources.
Exam 1;
North America
South America
North Africa
Southern Africa
Middle East
Central Asia
Australia
Project Presentations
Project Presentations; Conclusions
Exam 2: (Final)

Expected Learning Outcomes:

After completing this course, the student is expected to 1) Be able to locate the arid and semiarid regions on Earth and in each case explain the climatic reasons for the aridity. 2) Understand the adaptations plants and animals have made to live in arid regions. 3) Explain why the hydrology, soils and geomorphology of arid and semiarid lands are different than in wetter environments. 4) Knowledgably discuss human adaptation to drylands. 5) Knowledgably discuss land degradation in arid and semiarid lands.

Criteria for Grading:

Exam 1 (50 points).
Exam 2 (50 points).
Term Paper (50 points). Topic must be approved. 10 to 15 pages, double spaced.
Book Report (25 points). Book must be approved.
Class Project (25 points).

Class Attendance:

Attendance is encouraged, but does not directly affect a student's grade.

MAJOR TOPIC: Agricultural Science and Natural Resources

NRM 5317 WATERSHED MANAGEMENT (3 credit hours) **REQUIRED COURSE**

Faculty Information:

Name: Dr. Ernest B. Fish Office: 102 Goddard Building Email: ernest.fish@ttu.edu

Course Information:

- **Prerequisites:** Consent of Instructor
- **Required Text:** Brooks, K. N., P. F. Folliott, H. M. Gregersen and L. F. DeBano. 2003. Hydrology and the Management of Watersheds. 3rd Edition. Iowa State University Press. Ames, Iowa. 574 pp

Course Description and Purpose:

To provide the student with an understanding of the watershed as a unit of resource oriented planning and development. To provide information on the principles and objectives of watershed planning; physical description of watersheds; relationships between land use conditions and the water delivery character of watersheds.

Course Outline:

I. Introduction
- A. Overview of water resources and watershed planning
- B. Historical development of watershed planning
- C. Specialized terminology

II. Water Resource Problems
- A. Absolute supply problems
- B. Regimen or timing problems
- C. Quality problems

III. Watershed Planning and Application
- A. Objectives
- B. Contents
- C. Procedures
- D. Summary

IV. Hydrologic Processes on Watersheds
- A. The hydrologic cycle
- B. Energy balance concept
- C. Active surface concept
- D. Precipitation
- E. Water losses
  - 1. Interception 2. Evaporation 3. Transpiration
- F. Water movement into and through the soil profile
  - 1. Infiltration 2. Percolation
- G. Runoff

V. Erosional Processes
- A. Water
- B. Wind

VI. Watershed Protection
- A. Introduction
- B. Prevention of damages associated with various resource uses
  - 1. Road aspects 2. Forestry aspects 3. Range and wildlife aspects
  - 4. Recreational use aspects 5. General considerations

VII. Watershed Restoration
- A. Introduction
- B. General considerations
- C. Structural measures
- D. Vegetative measures

VIII. Water Yield Manipulation
- A. Alpine life zone
- B. Montane life zone
- C. Phreatophytic manipulation
- D. Review of specific studies and results

Expected Learning Outcomes:

- To provide the student with a knowledge of techniques and sources for watershed planning and application.
- To provide the student with a background knowledge of water resource problems and the historical development of watershed planning.
- To provide the student with a knowledge of the hydrologic cycle components and understanding of their functional relationships.
- To provide the student with a basic knowledge of erosion processes.
- To provide the student with a knowledge of watershed protection principles and techniques involving various types of natural resource management.
- To provide the student with a basic knowledge of watershed restoration practices.
- To provide the student with a basic knowledge of the results of water yield control efforts resulting primarily from vegetative manipulation on the watershed.
- To provide the student with a sufficient background to enable him or her to make sound land planning recommendations based on the objectives of watershed planning and other resources.

Criteria for Grading:

Graded material will consist of two hourly exams and a final exam, all of which carry equal weight and are comprehensive in nature. Additionally, unannounced quizzes, various problem sets and projects may be assigned throughout the semester. Total point accumulation for the entire course is normally 450-550. Letter grades for the course are based upon the following percentage categories applied to the total available number of points during a semester.

A	**90-100**
B	**80 - 90**
C	**70 - 80**
D	**60 - 70**
F	**<60**

Student must pass the final exam to receive a passing grade for the course.

Class Attendance:

100 points is allocated to class participation. Five points are deducted for each unexcused absence.

AAEC 5314 Environmental Economics and Policy Analysis

Faculty Information:

Dr. Jeff Johnson Agricultural Sciences jeff.johnson@ttu.edu

Course Description:

In this course we will distinguish between natural resource issues and environmental issues. Natural resource management deals with resources such as water, oil and gas, forests, wildlife, and agriculture. The issues faced by natural resource managers are generally supply and distribution of those resources in a sustainable manner. Environmental issues include pollution of resources such as water, air, or land and focus on policies and economic tools that will reduce, mitigate, or prevent pollution.

Learning Outcomes:

This course has one general learning outcome. Upon completion of this course, you will be able to understand and use basic economic concepts to evaluate natural resource and environmental issues. Additionally, each section has lesson objectives that support those of the overall course.

Course Outline:

a. Section 1. Economic Concepts

Learning Outcomes: Upon completion of this section of the course, the student will be able to understand the following economic concepts in preparation for using the concepts to analyze policies:

Understand how economics is used to value the environment.
Understand concepts of net benefits, net present value, and static and dynamic efficiencies
Understand risk assessment, valuation methods, and discount rate issues
Understand property rights and externalities
Understand intertemporal fairness and economic sustainability

b. Section 2. Natural Resource Economics

Learning Outcomes: Upon completion of this section of the course, the student will be able to:

Understand the concepts of efficient intertemporal and market allocations.
Identify and discuss major issues pertaining to management of energy, water, agriculture, forest, and commercially valuable species.
Analyze selected policies of one of the above natural resources using the economic methods discussed.

c. Section 3. Environmental Economics

Learning Outcomes: Upon completion of this section of the course, the student will be able to:

Understand efficient and market allocation of pollution and efficient and cost-effective policy responses to pollution.
Identify and discuss major environmental issues of local air pollution, regional and global pollutants, transportation, water pollution, solid waste, and toxic waste.
Analyze selected policies of one of the above environmental issues the economic methods discussed.

Methodology:

You will meet the course learning objectives through individual study of the required readings, review and analysis of pertinent issues, research and review of additional readings, and the completion of course written requirements. You may discuss the subject matter with others who might contribute to your learning.

a. The lesson order takes you from understanding of economic concepts, to natural resource management issues, environmental issues such as pollution mitigation and prevention, and finally to issues of sustainability.

b. In each section, you will develop the concepts and issues through a series of readings from the textbook and from articles from other sources. In sections 2 and 3, we will analyze the economics of various issues through specified readings, then you will provide an economic analysis of one issue of your choosing and approved by the instructor.

c. A writing requirement will be designated for each section. The requirement for sections 2 and 3 will pertain to your selected issue.

d. The final exam will be a paper dealing with a sustainability issue that will require you to use concepts developed throughout the course.

e. Your comprehension and knowledge of the material in each lesson is evaluated. In general you should be able to answer the requirement satisfactorily from the material within the lesson. In all of

the requirements, I am interested in how you use the concepts to develop the solution to the proposed problems. I am interested in your thoughts and how you express them; however, you should have some basis for your thoughts. Your solution to the writing requirement should answer the questions in a manner that shows your comprehension of the course material.

Course Materials:

The resources listed below will be used throughout the course and contain assigned readings and references required to achieve the learning objectives and complete the course requirements.

Tietenberg, T. Environmental Economics and Policy. Fifth Edition. Pearson Addison Wesley Publishing. 2006. ISBN-13: 9780321348906

Ellsworth, B. and J.A. Higgins. English Simplified. Tenth Edition. Longman Publishers. 2004.

TTU Guidelines for Dissertations and Theses. Chapter 2.
http://www.depts.ttu.edu/gradschool/current/THDGuidelines.php

Written Requirements:

All grades for this course will be earned through written assignments. Ellsworth and Higgins publication is a quick refresher and good reference for grammar and punctuation usage. Use the TTU guidelines for proper format of the assignments.

AGSC 5303 ECOLOGY OF GRAZING LANDS SYSTEMS (3 credit hours)

Faculty Information:

Dr. Vivien G. Allen Dept. of Plant and Soil Science, Texas Tech Felician@ttu.edu
Dr. John Fike Dept. Crop and Soil Env. Sci., Virginia Tech Blacksburg jfike@vt.edu
Dr. Rob Kallenbach Div. Plant Sciences, U. Missouri Columbia KallenbachR@missouri.edu
Dr. Paul Olenbusch Pasture and Range Mgmt., Kansas State U. (Retired) ole7734@suddenlink.net
Dr. John Waller Dept. Animal Science, U. Tennessee jwaller@utk.edu

Course Information:

- **Prerequisites:** Verification of qualification by the student's major professor and permission of the instructor is required. Because students will come from a number of different institutions with differences in curricula, prerequisites must be in subject matter and not in specific courses. It is recommended that students should have completed at least one course at the junior or higher level in each of five of the following subject matter groups prior to taking this class,

  Group One: Forage Crop Ecology, Forage Management, Range Management, Range Improvement
  Group Two: R u m i n a n t, Nutrition, Feeds and Feeding, Equine Nutrition, Beef Cattle Nutrition, Dairy Cattle Nutrition, Beef Cattle Management, Sheep Management Dairy, Cattle Management, Ruminology
  Group Three: Soil Fertility and Fertilizers
  Soil Chemistry Soil
  Management Soil Physics
  Soil Genesis and Morphology
  Group Four: Biochemistry, Physiology (Plant or Animal), Toxicology
  Group Five: Statistics, Biometry
  Group Six - A course in group six can be substituted for meeting a requirement in groups 1 through 5 Ecology Economics Farm Management Plant Taxonomy Agrostology Wildlife Management
- **Required Text:** No required text
- Other required supplies or financial obligations: A $600 (US) field-trip fee is charged for each student. This fee covers transportation costs during the field trip, lodging, and meals. Students are responsible for transportation to the departure point for the trip and for their return from the ending point of the trip.

Course Description and Purpose:

A field oriented course that takes participants into diverse grazing lands ecosystems across several states and may include other countries. Students learn about (a) the components and functions of grazing lands and how these vary in different ecoregions, (b) research needs, objectives and techniques in soil-plant-animal research, (c) forage-livestock ecology and systems in grazing lands (cropland, pastureland, rangeland and forestland), (d) the role of forages in conservation practices, wildlife habitat, and sustainable agriculture, and (e) industries involved with forages and livestock.

This is a graduate level course that includes a two-week field trip and is open to students who meet the qualifications. Graduate credit is received through your home institution and is credited to your program of study. Enrollment is limited to about 24 students and is taught during the first summer semester (quarter). Routes for the field trip will be different each time the course is offered, and students will travel through widely divergent ecosystems. International trips offered in some years.

Forages play a key role in addressing the issues of sustainability of agriculture and the environment. Forages are grown on more than half of the land in the United States. Private grazing lands occupy more than one-third of the land area in the lower 48 states. Forages and grazing lands are central to soil conservation, clean water, wildlife habitat, recreation, and open space, and they provide the major portion of the diets of domesticated ruminants and equines. As we seek solutions to the complex issues of maintaining agricultural production while preserving and protecting the environment and our future productive potential, we find that forages are central to these issues. It is critical that we provide learning opportunities for students that allow them to comprehend broad principles that extend across ecoregions. Students must take an integrated, systems approach to solving problems of agriculture and the environment. This can best be taught by bringing together an array of expertise and providing exposure to a broad range of sites.

While multidisciplinary courses such as this are needed, few universities have the required number of graduate students and the attendant resources to offer them. The multi-university nature of this course allows students and faculty from any cooperating university to participate. Benefits of this process include the interaction and sharing of knowledge among students and professors from a number of institutions and areas of expertise. Because faculty and students are from various universities, students become more knowledgeable about programs in other areas.

Course Outline:

No textbook is required. A core set of reading assignments provides the necessary background information. Selected reading assignments from publications and technical papers will familiarize students with the sites to be visited as well as with the professionals they will meet. Prior to departing on this trip, four modules are to be completed by students. This will be conducted using an online 'Knowledge Hunt' where students are directed to locate and synthesize specific information relevant to understanding information during the trip and better equipping them to ask relevant questions. This is to be completed between March 1 and May 1.

During the class, a Daily Journal must be kept by each student. At the end of the trip, the student should be able to articulate: (a) What this experience has meant to them. (b) How they can apply information gained to their future careers (teaching, research, production, etc).(c) How this experience relates to their graduate program. (d) How this course has changed their ideas of what they might do in the future. (e) How it changed their perspective of grasslands and their function within ecosystems and ecotomes across ecoregions. (f) What impact the course has had on them.

Expected Learning Outcomes:

1). To gain first-hand experiences in grazing land ecology through various ecoregions and to learn about techniques to address education and researchable needs. Students will become familiar with research needs and objectives in several geographical and climatic areas, techniques used in soil-plant-animal research, forage-livestock ecology, systems that include native and/or introduced forage species, and intensive and extensive management. Students will be able to qualify and quantify differences in ecosystems and the resultant effects on forage-livestock systems and agriculture in general. By familiarizing students with different ecosystems, they will be better able to integrate grazing management, watershed management, wildlife issues, and conservation of natural resources.

2). To gain interactions with professionals active in the multidisciplinary areas of forage livestock research, teaching, extension, industry, and production. As a result, students will gain a greater appreciation and knowledge of the interdisciplinary nature of forage-livestock research. The importance of forage-livestock systems as an integral component of agriculture and how they contribute to productive, economically viable, socially acceptable, and sustainable agricultural systems will become evident to students.

Criteria for Grading:

Grading is based on completion of pre-trip modules and upon participation in class activities during the two-week trip. An oral exam is given at the conclusion of the trip in a group setting.

Class Attendance:

Policy: Mandatory. Non-attendance constitutes withdrawal from this class.

ATMO 5302 WEATHER, CLIMATE AND APPLICATIONS (3 credit hours)

Faculty Information:

Colleen A. Leary Office - BA 1207 colleen.leary@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** Meteorology, Understanding the Atmosphere, by Ackerman and Knox (1st Edition). Please bring your textbook to class.

Course Description and Purpose:

Teaches basic principles of atmospheric science, with particular emphasis on applications, including severe weather, air pollution, and global climate change.The Atmospheric Science Group in the Department of Geosciences offers this graduate course to contribute to the Multi-Disciplinary Science M.S. degree program for elementary through secondary science teachers. The course's intrinsic value lies in its use of basic physical principles to explain interesting and important phenomena in our atmospheric environment. Understanding phenomena like clouds, precipitation, and winds add interest and meaning to watching the sky. Understanding phenomena like hurricanes, flash floods, lightning, severe thunderstorms, and tornadoes increases appreciation of the strength and intensity of natural forces. Learning the facts about prolonged exposure to ultraviolet radiation, air pollution, extreme heat and cold, extreme wind and cold, and extremes in pressure makes it less likely that we and those in our care will suffer their ill effects. Our ability to contribute to discussions and decisions about public policy will increase along with our knowledge of air pollution, climate, global warming, ozone holes, and El Niño.

Course Outline:

Class	Date	Subjects and Textbook Chapter and Page References
1.	29 Aug.	Weather elements; composition of the atmosphere; air pollution; ozone; ozone holes; radiation; energy balance; greenhouse effect; temperature; stability Chapter 1: Pages 1-18 Chapter 2: Pages 27-31, 32-33, 36-44, 47-52 Chapter 3: Pages 57-59, 65, 68-70, 74-76 Box 3.1 Chapter 4: Pages 110-112 Chapter 10: Pages 301-304 Chapter 15: Pages 433-438, 440-441
2.	12 Sept.	Seasons and temperature; winds and advection; climate typing with respect to temperature; growing, heating, and cooling degree days, wind chill, heat index; humidity Chapter 2: Pages 44-47, 50-53 Chapter 3: Pages 59-65, 70-81 Chapter 4: Pages 86-94 Chapter 14: Pages 401-403
3.	19 Sept.	Fog and clouds; how clouds produce rain; climate typing with respect to precipitation; dew and frost; weather modification; frozen precipitation; icing; visibility Chapter 4: Pages 92-123 Chapter 2: Pages 32-36, 50-53 Chapter 12: Pages 355-356 Chapter 14: Pages 401-403
4.	26 Sept.	Remote sensing; radar, satellites Chapter 5: Pages 132-148
5.	3 Oct.	Catch up or move ahead day. Class ends at 7:30 p.m. on this night only
6.	10 Oct.	Measuring pressure; winds and forces; thermal circulations; sea breeze, mountain winds, and monsoons; general circulation of the atmosphere and oceans Chapter 1: Page 20 Chapter 5: Pages 130-132 Chapter 6: Pages 159-186 Chapter 7: Pages 190-206 Chapter 12: Pages 351-352; 353-354
7.	17 Oct.	El Niño Chapter 8: Pages 209-222 Chapter 2: Pages 66-69

8. 24 Oct. Hurricanes
   Chapter 8: Pages 223-245
9. 31 Oct. Air masses, fronts, and extra-tropical cyclones
   Chapter 1: Pages 18-24
   Chapter 2: Pages 31-32
   Chapter 5: Pages 128-132
   Chapter 9: Pages 249-268
   Chapter 10: Pages 271-304
   Chapter 12: Pages 342-343; 350-351; 352-353 Box 12.4
10. 7 Nov. Weather forecasting; stability and convection; air parcels
   Chapter 13: Pages 363-397
   Chapter 1: Pages 21-24
   Chapter 2: Pages 32-36
   Chapter 3: Pages 74-79
   Chapter 12: Pages 339-342, 354-355
11. 14 Nov. Thunderstorms and tornadoes; lightning; the dry line; microbursts
   Chapter 11: Pages. 307-335
   Chapter 12: Pages. 344-350
12. 21 Nov. Climate types
   Chapter 14: Pages. 401-411
13. 28 Dec. Climate change
   Chapter 14: Pages 411-428
14. 5 Dec. Global warming
   Chapter 15: Pages 431-454

Expected Learning Outcomes:

After completing this course you will be able to:

- Calculate heating, cooling and growing degree-days, utilize wind chill and heat index charts, and explain the health effects of extremely high and low temperatures, air pollution, and exposure to ultraviolet radiation.
- Interpret the appearance of the sky by identifying the major cloud groups and their locations within large and small weather systems.
- Explain the possibility of global warming and the roles land-surface changes, air pollution, greenhouse gases, clouds, and the oceans in climate change.
- Analyze force-balance concepts and relate them to horizontal wind patterns that explain vertical air motions and weather in high and low pressure systems.
- Differentiate between hurricanes (tropical cyclones) and extra-tropical cyclones in terms of their origins, life cycles, temperature distributions, precipitation patterns, and wind patterns.
- Combine basic information about the atmosphere and the ocean to construct a conceptual model of the El-Niño-Southern Oscillation.
- Characterize the different stages of the life cycles of thunderstorms and tornadoes and point out likely areas for the occurrence of various types of severe thunderstorm weather.
- Critique weather forecasting methods, including numerical weather forecasts.
- Group different geographical areas by type of climate and explain the factors that determine climate type.

Criteria for Grading:

The expected learning outcomes for this course will be assessed by:

- In-class graded quizzes, In-class application activities, Polling the class, Class discussions, Active learning activities

Class Attendance:

Attendance at every class is an important part of this course.

BIOL 5330 ADAVANCED LANDSCAPE ECOLOGY (3 credit hours)

Faculty Information:

Name: Dr. Nancy E. McIntyre Office: Room 420 Biology Building nancy.mcintyre@ttu.edu

Course Information:

- **Prerequisites**: Instructor consent
- **Required Text**: Gergel, S.E., and M.G. Turner, eds. 2002. *Learning Landscape Ecology: A Practical Guide to Concepts and Techniques*. Springer, New York.
- Other required supplies or financial obligations: 1GB (minimum size) flash drive

Course Description and Purpose:

Landscape ecology is the study of the effect of spatial patterns on ecological processes and how those processes in turn create environmental patterns. This field represents a new awareness among ecologists that spatial patterning can no longer be ignored nor environments assumed to be homogeneous for logistical convenience; rather, spatial patterning is now recognized to be a dynamic force in ecology and not just a statistical nuisance. Fundamental principles of landscape ecology serve as foundations for decision-making and problem-solving in conservation biology, natural resource management, and urban planning and development.

Course Outline: Weekly course outline found at
http://www.biol.ttu.edu/faculty/nmcintyre/Landscape%20Ecology/topics.htm

Expected Learning Outcomes:

Upon successful completion of course requirements, students will be able to quantify spatial heterogeneity and its effects on biological processes affecting individuals, populations, and communities (including dispersal, risk of extinction, and diversity), and to discuss why such skills are necessary to conservation and natural resource management (e.g. in terms of reserve design and placement). There will be a weekly computer lab session, where students will conduct hands-on exercises; after successfully completing this class, students will be able to perform the most common methods of data analysis used in landscape ecology, including Markov and neutral landscape modeling and spatial statistics such as semivariance and autocorrelation analyses, using software packages that are standards in the field, including Fragstats and Rule.

Methods for Assessing Learning Outcomes:

(1) student performance on lecture exams
(2) student performance on weekly lab exercises
(3) student performance on cumulative lab exam
(4) change in performance on a pre/post diagnostic test
(5) student performance on cumulative lecture final exam
(6) participation in discussion section held outside normal course hours

Criteria for Grading:

10% on exam I
10% on exam II
10% on exam III
30% on cumulative final lecture exam
40% on lab

Requirements for Graduate Students:

Grad students will be expected to exhibit a more thorough and synthetic mastery of the subject; consequently, they will have different tests from undergrads. Grad students will also be involved in a regular discussion section, during which papers from the recent and classic landscape ecology primary literature will be examined and critiqued.

Absences and Missed Assignments:

Because there is a causal relationship between attendance and performance, I do take note of attendance. Make-up assignments will be given only in the event of a satisfactory, written excuse (e.g. doctor's note or TTU-sanctioned absence). Students with unexcused absences should not even *think* of enquiring about how to improve their grade, extra credit, or the like.

CE 5361 SURFACE WATER HYDROLOGY (3 credit hours).

Faculty Information:

Dr. Ted Cleveland Dept. of Civil Engineering

Course Description and Purpose:

Advanced study of hydrologic cycle: hydrologic abstractions, surface-runoff mechanics, hydrographs, baseflow separation, data analysis, reservoir and channel routing, and an introduction to rainfall-runoff modeling.

Expected Learning Outcomes:

The purpose of this class is to study hydrologic processes in the context of analysis and design and to apply selected hydrologic models to the analysis of real watersheds.
The student will be able to
1. Delineate watersheds by their topographic and anthropegenic features1, and estimate various physical metrics of a watershed (length, slopes, etc.).
2. Analyze, synthesize, and apply runoff hydrographs for engineering design.
3. Analyze, synthesize, and apply abstractions (storage and losses) for engineering design.
4. Route hydrographs using a variety of hydrologic technologies.
5. Read, synthesize, and communicate ideas presented in current and historical technical literature.

ABET Program Outcomes Addressed in CE 53612:

3[a]. Ability to apply knowledge of mathematics, science, and engineering.
3[b]. Ability to design and conduct experiments, as well as to analyze and interpret data.
3[e]. Ability to identify, formulate, and solve engineering problems.
3[i]. Recognition of need for life-long learning.
3[k]. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
8[d]. Proficiency in water resources engineering.

Course Schedule: by week

1 Hydrologic cycle. Mass, momentum, and energy. Conduit, open, and porous flow.
2 Atmospheric, and sub-surface water.
4 Surface water, measurements and data sources.
6 Unit Hydrographs. Convolution/deconvolution and synthesis.
8 Hydrologic and hydraulic routing
9 Mid-term Exam: All covered
10 Probability estimation, and frequency analysis.
12 Design storms and event modeling.
14 Continuous-simulation modeling
Final Exam: All covered

Prerequisites:

Mastery of material from CE 3354 or an equivalent physical hydrology course is required.

Attendance:

If you come to class every day, you won't miss anything. Please let the instructor know if you must miss a class for a legitimate reason.

Grading:

Final grades are determined based on performance during the semester. Letter grades will be assigned using University standards. The approximate weighting of graded material in determining the final grade is as follows:

Article Reviews 10%
Homework 40%
Examinations 50%

CE 5363 GROUNDWATER HYDROLOGY (3 credit hours)

Faculty Information:

Dr. Ken Rainwater Office CIV 203D ken.rainwater@ttu.edu

Course Information:

- **Prerequisite:** CE 3354 or consent of instructor.
- **Textbook:** Fetter, C.W., 2001, Applied Hydrogeology, 4th ed., Prentice Hall, Englewood Cliffs, New Jersey.

Other Required Materials:

McDonald, M.G. and Harbaugh, A.W., 1988, A Modular Three-Dimensional Finite-Difference Groundwater Flow Model, Chapter A1, Book 5, Techniques of Water-Resources Investigations of the United States Geological Survey, USGS, Reston, Virginia. Also other MODFLOW support files.

Course Purpose:

The purpose of this course is to introduce the student to the hydrogeologic, hydrologic, and engineering principles that are applied to problems of groundwater investigation, development, production, and quality.

Course Objectives:

Upon successful completion of this course, the student will be able to do the following.

1. Determine hydrogeologic parameters from geologic materials, field tests, and estimates.
2. Describe subsurface conditions with proper hydrogeologic terminology.
3. Apply analytical and numerical modeling techniques to simulate groundwater flow in ideal and nonideal aquifer systems.
4. Recognize the importance of groundwater quality in consideration of regional flow descriptions and water resource development.

Topics:

1. Connections between geological and geotechnical information to hydrogeologic and hydraulic parameters.
2. Description, measurement, and/or estimation of aquifer hydraulic parameters.
3. Construction of hydraulic head contours for homogeneous, isotropic conditions.
4. Application of Darcy's Law for horizontal and vertical flow.
5. Application of appropriate analytical relationships for radial flow to wells.
6. Performance and analyses of pump tests for aquifer parameters.
7. Performance and analyses of slug tests for aquifer parameters.
8. Application of superposition to represent aquifer boundaries and well interference.
9. Application of MODFLOW for numerical simulation of non-ideal aquifer systems.
10. Well drilling, development, construction, and rehabilitation procedures.
11. Regional groundwater flow patterns, recharge and discharge areas.
12. Unsaturated zone conditions.
13. Equilibrium water chemistry, especially carbonate equilibrium.
14. Groundwater contamination concerns.
15. Development and management of well fields.
16. Groundwater rights.

Class Schedule:

Class meets fifteen weeks, three times per week for 50 minutes per class session.

Evaluation Process:

1. Homework – There will be six to eight homework assignments scattered through the course, usually with two class days (or one week) between assignment and due date allowed for completion. There is no late policy. Solutions should include brief problem statements and outline the solution approach leading to a well-labeled answer. Work on one side of the paper only. Illegible homework will be returned ungraded. Computer applications will be used on some assignments. Students are expected to be computer literate. When spreadsheets are used, sample calculations are required, and each student must turn in his/her own result.

2. Project – There will be one individual modeling project during the middle of the semester. The groundwater model will be available for PC use.

3. Exams – Two exams, one at midterm and one during the final period, will be given. No make-up exams will be given for simple absence. If a student has an emergency conflict with any assignment, prior notice must be given to the instructor.

4. Class Conduct – Students are expected to treat each other and the instructor respectfully. All students are expected to observe appropriate personal hygiene practices.
5. Grading Policy

	CE 5363	
Homework	20%	
Two Exams	40%	
Project		20%
Two Reviews		20%
	100%	

Contribution of Course to Professional Component of the Curriculum:

This course is one of the two groundwater courses in the MENVE curriculum. This course builds on the water resources background begun in CE 3354 Engineering Hydrology by emphasizing hydraulics of groundwater flow in simple to complex situations. This course prepares students to deal with investigation and development of groundwater resources, an important part of the nation's water supply. The following graduate course, CE 5364 Groundwater Transport Phenomena, emphasizes the movement of dissolved and liquid phase contaminants in the subsurface. These two courses complete the preparation of the students for most practical problems in groundwater quantity and quality. Individual projects are used in both courses to simulate the working environment in engineering practice.

Relationship to Program Objectives:

This course provides the conceptual framework, mathematical tools, and modern software techniques to insure the students' proficiency in engineering problems associated with use of groundwater resources. As water supply and quality issues are integral for civil and environmental engineers, this material addresses the objectives of both the civil engineering and environmental engineering degree programs.

ABET Program Outcomes:

3(a) an ability to apply knowledge of mathematics, science, and engineering
3(c) an ability to design a system, component, or process to meet desired needs
3(e) an ability to identify, formulate, and solve engineering problems
3(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
8(e) proficiency in water resources engineering
8(g) design a system, component, or process in more than one civil engineering context

CE 5364 GROUNDWATER TRANSPORT PHENOMENA (3 credit hours)

Faculty Information:

Dr. Ken Rainwater Office CIV 203D ken.rainwater@ttu.edu

Course Information:

- **Prerequisites:** Consent of Instructor
- **Required Text**: *Ground Water Contamination*, 2nd ed., Bedient, Rifai, and Newell. Some computer manuals will be required at different times during the semester.

Course Description and Purpose:

Study of sources and fates of contamination in groundwater. Mathematical modeling of reactive and nonreactive pollutant movement. Aquifer restoration strategies.

Course Outline:

Week	Topics and **Events**
1	Introduction (Ch 1), Contamination Sources (Ch 4)
2	Anisotropy, Transport Mechanisms (Ch 6)
3	Fate Processes (Ch 7), Modeling Attenuation (Ch 8)
4	Risk Assessment
5	Risk Assessment
6	Numerical Models (Ch 10), Attenuation and RBCA (Ch 12)
7	MODFLOW/MODPATH/MOC3D Model, **First Review Due**
8	**Exam 1**
9	Site Investigations (Ch 5)
10	Spring Break
11	Flow and Transport in Unsaturated Zone (Ch 9)
12	CHEMFLO Model
13	NAPLs (Ch 11)
14	Remediation Alternatives (Ch 13)
15	Legal Protection (Ch 14), **Second Review Due**
16	
17	Review

Expected Learning Outcomes:

The student will be trained in the fundamental descriptions of the physical and chemical processes that control the movement of contaminants in the subsurface. Analytical solutions and existing computer models will be presented to typify the available tools with corresponding limitations.

Criteria for Grading:

1. Homework and projects – Several homework and project assignments will be distributed through the semester, weighted according to their relative scopes. After the graded homeworks are returned, the solutions will be posted. Use of spreadsheets is encouraged for repetitive tabular calculations and graphs, but sample calculations are required for full credit. Each student must submit his/her own spreadsheet.
2. Article reviews – Two brief (3-5 pages, typed, double-spaced) reviews of articles from the professional literature will be required during the semester.
3. Exams – Two exams will be given. The final exam will only cover the material after Exam one. No make-up exams will be given for simple absence.
4. Class conduct – Students are expected to treat each other and the instructor respectfully. All students are expected to observe appropriate personal hygiene practices.

Grading Policy

Homework and projects: 40% Article reviews: 20% Exams: 40% Total: 100%

Class Attendance:

Required

CE 5394 NATURAL SYSTEMS FOR WASTEWATER TREATMENT (3 credit hrs.)

Faculty Information:

Dr. C. B. Fedler, Rm. 202 Civil Engineering Building

Required Texts:

-Natural Systems for Waste Management and Treatment, by S.C. Reed, R.W. Crites and E.J. Middlebrooks. Second Edition, ISBN 0-07-060982-9.

-EPA, 1981, Process Design Manual: Land Application of Municipal Wastewater (EPA-625/1-81-013)

Course Objective:

The objective of this class is for a student to learn how to design various types of natural wastewater treatment systems for treating various types of wastewater streams.

Course Outline:

Introduction
Examination of municipal wastewater
General concepts of land application of wastewater
Fate of wastewater constitutents

Slow Rate Systems
Design considerations
Crop selection, buffer area, drainage, retention ponds, crop harvesting, storm water, irrigation systems
Pre-application treatment
Water application efficiency - sprinklers
Land limiting constituents
Nitrogen removal and nitrogen balance
Land requirements
Determination of storage requirements
Fixed irrigation schedule, variable leaching (TWC method)
Fixed leaching, variable irrigation
Operation and maintenance
Monitoring/Management

Rapid Infiltration Systems
Basic concepts of the system
Nutrient removal processes
Design considerations
Hydraulic loading rate, infiltration rate, mound dissipation
Operation and maintenance
Monitoring/Management

Overland Flow Systems
Basic concepts of the system
Nutrient removal processes
Design considerations
Crop selection, hydraulic loading, slope, infiltration rate
Start-up problems, temperature effects
Operation and maintenance
Monitoring/Management

Pond Systems
Aerobic
Anaerobic
Others

Wetland/Aquacultural Systems
Components
plants, soil, organisms, etc.
Pond design
Performance
Design considerations
Operation and maintenance

Land Application of Hazardous Wastes (if time permits)

Basic concepts of the system
Review of hazardous waste regulations
Review of reported treatment systems
Process required to obtain a permit
Design philosophy

Learning Outcomes:

After completing this course, students will be able to:

1) Calculate the mean crop consumptive use for various plants and free surface water bodies
2) Analyze the land limiting constituents for a surface application system for wastewater
3) Complete a water balance, nutrient balance, and a salt balance for a surface application system
4) Determine the storage requirements for a natural wastewater treatment system
5) Design a slow rate land application system
6) Design a overland flow land application system
7) Design a rapid infiltration land application system
8) Design the various types of pond systems for treating wastewater
9) Design a surface flow wetland
10) Design a subsurface flow wetland

Outcome Assessment:

GRADING SCALE - PERCENTAGE OF GRADE
Problem Sets - 25%
Semester Project - 25%
Midterm Exam - 25%
Final exam - 25%

NOTE: All assignments, computer programs and the design project must be turned in to obtain a passing grade in the course. Late work will be deducted by half the graded score unless prior arrangements have been made.

ENTX 6361 ENVIRONMENTAL AND WILDLIFE TOXICOLOGY (3 credit hours).

Faculty Information:

Dr. Phil Smith Institute of Environmental and Human Health

Course Information:

- **Prerequisite:** Organic chemistry, ecology, or consent of instructor.

Course Description and Purpose:

This course will address impacts of toxic substances on the fitness, survival, and reproduction of wildlife species. The procedures used to investigate these impacts will be presented. Environmental contaminants that will be discussed include pesticides, metals, petroleum products, persistant organic pollutants, and endocrine disrupting chemicals. The course will be taught from the perspective of an ecological risk assessor. This course will be valuable to future wildlife and environmental science professionals.

Course Outline:

January	Historical perspective of wildlife and environmental toxicology
	Laws and regulations pertaining to wildlife and environmental toxicology
	Principles of toxicology
February	Uptake, biotransformation, and elimination of toxic substances
	Ecological aspects of toxicology
	Integrating toxicology and ecology
	Exposure to contaminants among wildlife
	Biochemical and physiological measures of toxicity
	Quiz 1
	Terrestrial Ecotoxicology
March	Aquatic toxicology
	Pesticides and wildlife
	Pesticides and wildlife
	Spring Break
	Spring Break
	Metals and wildlife
	Metals and wildlife
April	Persistant organic pollutants and wildlife
	Persistant organic pollutants and wildlife
	Petroleum products and wildlife
	Quiz 2
	Endocrine disrupting compounds and wildlife
	Endocrine disrupting compounds and wildlife
	Emerging contaminant threats to wildlife
	Indirect and sublethal effects of contaminants in wildlife
	Ecological risk assessment
May	Final Exam

Grading Policy: Grades will be based on point totals accumulated on 2 quizzes, and a comprehensive final exam.

Quizzes = 100 x 2 = 200 points
Final exam = 150 points
Final letter grades will be assigned based on the following scale:

A = 315 – 350 points
B = 280 – 314 points
C = 245 – 279 points
D = 210 – 244 points
F = 0 – 209 points

The instructor reserves the right to curve grades upwards. Extra credit is possible, but will only be granted following additional effort by the student requesting the credit. Extra credit (up to 25 points) assignments may include, but are not limited to writing reviews of wildlife toxicology topics, or wildlife-based risk assessments.

Expected Learning Outcomes and Assessment:

Upon completion of this course the student should have a generalized knowledge of wildlife toxicology principles, a wide variety of environmental contaminants affecting wildlife populations, methods used to evaluate the exposure and effects of toxicants in wildlife, and the EPA risk assessment process. They should be capable of evaluating exposure and effects information as it relates to wildlife, and understand how these concepts are considered together to determine risk. In addition to the testing schedule detailed above, student learning of these concepts described above will be monitored by in-class discussions that will include frequent queries from the instructor.
Attendance: Expected, and highly recommended.

ENTX 6371 PROCEDURES AND TECHNIQUES IN ECOLOGICAL RISK (3 credit hours)

Faculty Information:

Dr. Philip N. Smith Institute of Environmental and Human Health phil.smith@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** 1. US EPA Risk Assessment Guidelines
  2. Ecological Risk Assessment for Contaminated Sites. Suter et al., eds., Lewis Publishers, Boca Raton, FL

Course Description and Purpose:

To provide students with a solid foundation in risk assessment methods. Specifically, students will learn how the ecological risk assessment framework developed by the U.S. Environmental Protection Agency is used to assess the potential hazards of chemicals in the environment with specific focus placed on hazardous waste sites (Superfund). □

Course Outline:

August	Syllabus
September	Course Outline, Goals, Strategies for Success
	What is risk, Risk Perceptions, Policy of Risk Assessment
	Risk Assessment Frameworks
	Problem Formulation, Assessment Endpoints
	Conceptual Models and Analysis Plans
	Quiz 1
	Analysis of Exposure
	Analysis of Exposure
	Analysis of Effects
October	Analysis of Effects
	Risk Characterization
	NO CLASS
	NO CLASS
	Risk Characterization
	Quiz 2
	Uncertainty Analysis
	Probabilistic Methods
	Risk Communication and Management
November	EPA FIFRA Risk Assessment Process AQUATIC
	EPA FIFRA Risk Assessment Process TERRESTRIAL
	Emphasizing Ecology in Ecological Risk Assessment
	Quiz 3
	Case Studies
	NO CLASS SETAC National Meeting
	Case Studies
	NO CLASS Thanksgiving
December	Case Studies
	Review
	COMPREHENSIVE FINAL EXAM

Expected Learning Outcomes:

Upon completion of this course the student should have a generalized knowledge of the EPA risk assessment framework, and how it is applied to risk assessments on hazardous waste sites. They should be capable of evaluating risk in terms of exposure and effects, and understand how these concepts are considered together to determine risk. Students should have a basic understanding of methods of integrating exposure and effects risks via several methods including the quotient method and probabilistic risk assessments. Students will learn how ERA relates to natural resource damage assessments. Students will also have a basic understanding of how ecological risk assessments are

applied to situations other than hazardous waste site evaluations (e.g. pesticide registration). In addition to the testing schedule detailed above, student learning of these concepts described above will be monitored by in-class discussions that will include frequent queries from the instructor.

Criteria for Grading:

Grades will be based on point totals accumulated on 3 quizzes, and a comprehensive final exam.

Quizzes = 100 x 3 = 300 points
Final exam = 150 points
Final letter grades will be assigned based on the following scale:

A = 405 – 450 points
B = 360 – 404 points
C = 315 – 359 points
D = 270 – 314 points
F = 0 – 269 points

The instructor reserves the right to curve grades upwards. Extra credit is possible, but will only be granted based on extreme circumstances and after considerable extra effort by the student requesting the credit. Extra credit (up to 25 points) assignments may include, but are not limited to writing reviews of, or performing risk assessments.

Class Attendance:

Expected, and highly recommended.

GEOG 5300 GEOGRAPHIC INFORMATION SYSTEMS (3 credit hours)

Faculty Information:

Dr. Kevin R. Mulligan Office - 208 Holden Hall kevin.mulligan@ttu.edu

Course Information:

- **Prerequisites:** Working knowledge of the Microsoft Windows environment.
- **Required Text:** Ormsby *et al.*, 2004, *Getting to Know ArcGIS Desktop, Second Edition*, Environmental Systems Research Institute, Redlands, California. This is a software course book that we will use as the basis for lab instruction. The book includes two CDs - a data CD and a 180-day timed version of ArcGIS 9. If you want to work at home, you will need both CDs and a computer running either Windows 2000 or Windows XP.
- **Other required supplies and financial obligations:** USB Flash Drive. To save your lab work, you need to purchase a USB flash drive early in the semester. Since GIS data can take up a lot of space, a 256 MB flash (or larger) is recommended.
  Required Lab: GEOG 5300 section 501 or 502.

Course Description and Purpose:

Geographic information systems are computer systems designed to manage and analyze spatial data, where spatial data can be any data that are tied to places or geographic coordinates. In this course we will develop a basic understanding of geographic information systems using ArcGIS, a very powerful and widely-used GIS.

Course Outline:

Introduction – What is a Geographic Information System?
Feature types and data structures (raster vs vector)
Types of maps (map scale and function)
Thematic mapping (choropleth, isoline, dot density, proportional symbol)
Data classification (natural breaks, quantile, defined interval, standard deviation)
The geographic grid (datums, ellipsoids, spatial reference, latitude and longitude)
Map projections (getting the Earth onto a flat map – cylindrical, conic and planer projections)
Projected coordinate systems (UTM coordinate system, state plane coordinate system)
Land division systems (public land surveys)
Topographic maps (map interpretation, marginalia and symbolization)
Effective map design (knowing the purpose of your map)
Data collection (land surveys, remote sensing, the Global Position System)
GIS analysis (basic measures, spatial relationships, spatial modeling and map algebra)
Designing a GIS (database design and implementation)
Metadata and accuracy (knowing the origins of data)
Data sources (data in the public domain - working with DEMs, DRGs and DOQs)
The Spatial Analyst extension to ArcGIS (working with raster data)
The 3D Analyst extension to ArcGIS (creating animations & 3D fly-throughs)

Expected Learning Outcomes:

1) Explain what a GIS is, how it works, and what it can do.
2) Analyze spatial data and create publication quality maps using ArcGIS.
3) Understand and apply basic cartographic principles (e.g. map projections, symbology and cartographic design).
4) Obtain GIS data from Internet sources and evaluate these data in the context of a given project.

Criteria for Grading:

There are two exams in this course (a midterm and a final), two lab quizzes, one basemap project and one final project. Each exam is worth 100 points and each lab quiz is worth 50 points. The basemap project is worth 50 points and the final project is worth 100 points. Your final course grade is therefore based upon a possible total of 450 points. To ensure a grade in this course you must meet the following minimum requirements: A - 90%, B - 80%, C - 70%, D - 60%.

Students are also expected to complete each of the lab assignments **during the lab class time**. Five (5) points will be deducted for each unexcused absence **and** five points will be deducted for each missed or incomplete exercise. Missed or incomplete lab assignments may be turned in late for credit with approval.

Exams and Quizzes: The exams and quizzes will consist of a combination of true/false, multiple choice, and short answer questions. The lecture exams will be based upon the lectures and reading assignments. The lab quizzes will be open-book and open-computer based upon the information covered in the labs.

Class Attendance:

You are expected to attend all of the lectures and labs and complete all of the lab exercises in lab. An excused absence does not relieve you of meeting all of the course requirements. If you have any problems during the semester, please let us know.

Make-Up Exams: You are required to take the exams and quizzes at the scheduled times. Exceptions will be made in the case of a documented serious illness, medical emergency, or other university approved excuse. If you have prior knowledge that an exam or quiz will be missed, you must inform one of us before the time of the exam or quiz. If you need to make up an exam or quiz, it is your responsibility to make arrangements as soon as possible.

Missed Information: If you miss a lab, it is your responsibility to complete the exercise on your own (or with the help of your classmates).

GEOG 5301 REMOTE SENSING OF THE ENVIRONMENT (3 credit hours)

Faculty Information:

Dr. Tina Delahunty Dept. of Economics and Geography tina.delahunty@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:**
- Other required supplies or financial obligations-- You are required to enroll in a lab section as part of this class.

Course Description and Purpose:

Remote sensing refers to the acquisition and analysis of imagery (spatial data) obtained using a remote platform, most often an aircraft or satellite. The imagery might be in the form of aerial photographs or the imagery might be digital in the case of airborne or satellite multi-spectral scanners. The purpose of this course is to develop a basic understanding of remote sensing and digital image processing techniques. In the first part of this course we will work with conventional black & white, color, and infrared aerial photographs. In the second part of the course we will work with digital satellite imagery. In particular, this course will focus on the use of remote sensing to solve spatial problems by integrating image processing and GIS analysis. To learn about image processing and geographic information systems, we will use a hands-on approach. In this course we will use the Image Analysis extension to ArcGIS and ERDAS Imagine.

Methods for Assessment:

Learning Outcomes will be assessed by the following methods:
Objective testing (Multiple choice, true-false, and fill in the blank questionnaires), Classroom assessment (Completion of, and perfomance on, laboratory assignments), and Individual reflection (Creation and presentation of PowerPoints and in-class discussion and debate regarding assignments). Each module of objective testing, classroom assessment and individual reflection is worth 10 points. At the end of the semester all points are totaled and averaged. Be aware that some 10 point assignments are easy and some are difficult. There will be no make-up assignments. If you do not attend a class you will receive a zero for the assignment(s) done or due on that day. 100% attendance is expected. Attendance is taken at the beginning of each class period. One 10-pointer is dropped for each student at the end of the semester. Grade distribution is based on standard 90% and above A, 80% and above B, etc. Performance on the assignments act as evidence that you are making progress in the course and that you are achieving the expected learning outcomes.

Expected Learning Outcomes:

1) Understand the sub-discipline's relationship to major geographic principles
2) Describe and discuss common uses of raster imagery and be aware of the breadth of disciplines that use remote sensing as a tool to monitor phenomena on the Earth
3) Understand the basics of the acquisition of moderate and high resolution raster data
4) Understand what the raw pixel data of an image represents on the Earth's surface and the concepts behind viewing imagery in different band combinations
5) Locate, download, and manipulate free moderate and high resolution imagery from the Global Land Cover Facility, EROS, TNRIS, Seamless USGS, and various online county and state organizations
6) Perform basic image manipulation in two free remote sensing software packages (Multispec and GRASS)
7) Perform advanced image manipulation in ERDAS: a) Interpret raw data in terms of ERDAS pixel data, histograms, and raster attribute options, b) Enhance imagery via contrast stretching and atmospheric correction, c) Perform unsupervised and supervised classification, d) Mask unwanted features from imagery, e) Clip imagery to political or other polygon boundaries, f) Quantify landscape change using image classification and recode techniques, and g) Perform accuracy assessment of classified imagery
8) Successfully rectify imagery in ArcGIS and define and reproject raster imagery in ERDAS and ArcGIS
9) Successfully import/export various raster image file types
10) Create map documents in ERDAS and ArcGIS
11) Communicate in remote sensing terminology

12) Be painfully aware of software and data compatibility issues

Criteria for Grading:

There are three exams in this course (two midterms and a final) and one final project. Each exam and the final project are worth 50 points. Your final grade is therefore based upon a total of 200 points. You are also expected to successfully complete all of the lab assignments and 10 points will be deducted for each missed or incomplete exercise. There is no extra credit work in this course. To ensure a grade in this course you must meet the following minimum requirements: A - 90%, B - 80%, C - 70%, D - 60%.

Exams: All of the exams will consist of a combination of multiple choice, short answer and short essay questions. The exams will be based upon the lectures, reading assignments and lab exercises. For each exam I will provide a general study guide outlining what the exam will cover.

Class Attendance:

You are expected to attend all of the lectures and labs and complete all of the exercises. An excused absence does not relieve you of meeting all of the course requirements. If you have any problems during the semester, please let me know.

GEOG 5302 ADVANCED GEOGRAPHIC INFORMATION SYSTEMS

Faculty Information:

Dr. Kevin R. Mulligan Office – 208 Holden Hall kevin.mulligan@ttu.edu

Course Information:

- **Prerequisites:** Working knowledge of the Microsoft Windows environment and ArcGIS. These requirements can be fulfilled with GEOG 5300 or an equivalent course.
- **Required Text:** none
- **Other required supplies and financial obligations:** USB Flash Drive. To save your work, you will need to purchase a USB flash drive. Given that GIS data can take up a lot of space, a 512 MB flash (or larger) is recommended.
  Required Lab: You are required to enroll in GEOG 5302 - section 501

Course Description and Purpose:

This course is a second course in GIS designed as a continuation of GEOG 5300. The intent of the course is to cover the principle extensions to ArcGIS (Spatial Analyst, 3D Analyst, and Geostatistical Analyst) and related topics dealing with the creation of GIS data, data sources, advanced cartographic techniques and Internet mapping.

Course Outline:

Introduction (course logistics and overview of the ESRI Virtual Campus)
Working with Rasters in ArcGIS 9 - Raster Basics
Working with Rasters in ArcGIS 9- Displaying Rasters in ArcMap
Spatial Analyst - Getting Started with ArcGIS Spatial Analyst
Spatial Analyst - Analyzing Surfaces
Spatial Analyst - Working with Map Algebra
Spatial Analyst - Interpolating Raster Surfaces
Spatial Analyst - Mapping Distance and Density
Spatial Analyst - Using Cell, Neighborhood, and Zonal Statistics
3D Analyst – Introduction to ArcGIS 3D Analyst
3D Analyst – Displaying 3D Data
3D Analyst – Symbolizing and Analyzing Data
3D Analyst – Creating and Converting 3D Data
3D Analyst – Calculating Raster Surfaces
3D Analyst – Interpolating Raster Surfaces
Geostatistical Analyst – Geostatistical Analysis of Rasters
Working with Internet map services – An introduction to ArcIMS and ArcGIS Server

Expected Learning Outcomes:

1) Explain the difference between the vector, raster and TIN data models
2) Perform advanced geospatial and geostatistical analyses of raster surfaces
3) Apply advanced cartographic techniques in the creation publication quality maps
4) Obtain GIS data from Internet sources and evaluate the quality of the data

Criteria for Grading:

Your grade in this course will be based on several factors: 1) successful completion of the ESRI Virtual Campus courses, 2) a midterm exam, 3) completion of assigned exercises, and 4) a final project. To ensure a grade in this course you must meet the following minimum requirements:
A - 90%, B - 80%, C - 70%, D - 60%.

Exams: The midterm exam will consist of a combination of multiple choice, short answer and short essay questions. The exam will be based upon the materials covered in the ESRI Virtual Campus courses.

Class Attendance:

You are expected to attend all of the scheduled classes and complete all of the Virtual Campus modules on time. An excused absence does not relieve you of meeting all of the course requirements. If you have any problems during the semester, please let me know.

Make-Up Exams: You are required to take the midterm exam at the scheduled time. Exceptions will be made in the case of a documented serious illness, medical emergency, or other university approved excuse

Missed Information: If you miss a lab, it is your responsibility to complete the exercise on your own (or with the help of your classmates).

GEOG 5309 SEMINAR IN REGIONAL ANALYSIS (3 credit hours)

Faculty Information:

Dr. Perry Carter Office - Holden 210 perry.carter@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** Reluctant Metropolis: The Politics of Urban Growth in Los Angeles by William B. Fulton Ecology of Fear: Los Angeles and the Imagination of Disaster by Michael Davis
  Cultural Economy of Cities: Essays on the Geography of Image-Producing Industries by Allen Scott
  Whitewashed Adobe: The Rise of Los Angeles and the Remaking of Its Mexican Past by William Deverell
  L.A. City Limits: African American Los Angeles from the Great Depression to the Present by Josh Sides

Course Description and Purpose:

This course is designed as a survey of issues in urban geography. Because urban geography's focus is the city (*a place*) rather than a particular *topic* the course covers a range of topics relevant to cities – politics, economics, culture, gender, ethnicity, urban migration, residential spaces, retail location, urban form, etc. Because all these issues co-exist and interact in one place—the city— the main aim of this course will be to understand the linkages among the many topics we study. Simply, we want to understand the city *as a whole* rather than understand specific parts of the city in isolation (its economy, its politics, its culture, etc.).

Urban geography takes a *spatial* approach to understanding cities, and urban geographers want to know where things are, why they are *there*, and why their location is important. Moreover, they are interested in *spatial patterns* in the city—they attempt to describe and explain the city's spatial layout. This *spatial* approach to cities—an approach that strives to understand how people and culture and power and relationships are embedded within the *spaces* of the city— is the defining feature of urban geography. The primary objective of this course is to teach you this spatial approach and to teach you how to critically examine cities.

The aims of this course will be explored using two specific urban examples – Los Angeles and Lubbock. By reading about Los Angeles and going out and studying Lubbock, students will get a better understanding of how to critically (to carefully analyze and interpret) urban landscapes. A secondary goal of this course is to develop students' writing and presentations skills. To further this goal, students will write a 10 page paper and will give a 15 minute power point presentation based on their paper topic.

Course Outline:

Date	Readings (chapters)	Quizzes	Summaries	Emailed questions
1-15				
1-22	Wolch: intro, Deverell: intro-1, Flamming: intro	1	1	1
1-29	Wolch: 1, Deverell: 2, Flamming: 1	2	2	2
2-5	Wolch: 2, Deverell: 3, Flamming: 2	3	3	3
2-12	Wolch: 6, Deverell: 4, Flamming: 3	4	4	4
2-19	Wolch: 5, Deverell: 5, Flamming: 4	5	5	5
2-26	Wolch: 8 , Flamming: 5, Gumprecht: intro-1	6	6	6
3-4	Fulton: 1, Flamming: 6, Gumprecht: 2	7	7	7
3-11	Fulton: 2, Flamming: 7-8, Gumprecht: 3	8	8	8
3-18	**Spring Break**			
3-25	Fulton: 3, Gumprecht: 4	9	9	9
4-1	Fulton: 4, Gumprecht: 5	10	10	10
4-8	Fulton: 5, Gumprecht: 6	11		11
4-15	**No Class**			
4-22	Fulton: 10 & 11	12		12
4-29	**➔ [Exam]**			
5-5	**Final Paper Due in my Office by 5:00**			

Expected Learning Outcomes:

This **Course has four goals:**

1. The development of a spatial view of urban landscapes – the ability to see places as the products of certain economic, social, and cultural decisions and histories as well as locations which derive their meanings via their relationships with other places.
2. The cultivation of a practice of critical thinking – an agnostic and persistently questioning method of thought.
3. Provide students the opportunity to learning by researching.
4. Provide students the opportunity to think through writing – placing a stream of coherent thoughts on a page.

Student Learning Outcomes	Assessment Activities
By the completion of this course student will:	
1) Demonstrate an understanding of the spatial view	1) Final paper
2) Show an ability to learn by researching	2) Final paper
3) Manifest developing critical thinking and evaluative abilities.	3) Emailed questions and class discussion of readings
4) Exhibit a grasp of a variety of urban issues	4) Weekly quizzes and summaries, and class discussions

Criteria for Grading:

Starting the second week of class students must go to the Los Angeles Times (www.latimes.com) and find an article dealing with LA (it can be anything that relates to the city) and type a half page summary of the article. There will be ten of these summaries each worth one point for a total of **10** points towards your final grade.

1. Summaries will be due at the beginning of class.
2. Starting the second week of class students must type a one page, single spaced, summary of that weeks readings. This summary should focus on the main themes of the readings and should include your thoughts on the readings. There will be thirteen weeks of readings and each summary will be worth one point for a total of **13** points towards your final grade
3. Starting the second week of class quizzes over the assigned reading will be given. There are thirteen weeks of readings and thus there will be thirteen quizzes each worth three points for a total of **39** towards your final grade.
4. One exam will be given which will cover everything read or presented in class up until that point. It is worth **14** points towards your final grade.
5. Students are to write a ten (10) page paper which **Must** be in the following format: 1) a cover page with the title of the paper and your name on it (not part of the 10 pages), 2) a bibliography containing all the sources cited in the text of your paper (not part of the 10 pages). You should cite at least 5 sources. 3) the text of you paper must be written in Times New Roman font 12 point (the font and point size used in this syllabus); the margins of the text must be 1 inch on all four sides; and the line spacing must be 1 ½. No matter how good your paper might be if you do not follow this format you will receive a zero on it and forfeit **16** points towards you final grade. Detail about the paper will be given in class.
6. The last two weeks of class each student will give a 15 minute PowerPoint presentation based on their papers. This presentation is worth **8** points towards your final grade. Detail about the presentation will be given in class.

Class Attendance:

Attendance is mandatory.

GEOG 5341 DIGITAL IMAGERY IN THE GEOSCIENCES (3 credit hours)

Faculty Information:

Dr. David Leverington Office – SC 316 david.leverington@ttu.edu

Course Information:

- **Prerequisites:** none
- **Required Text:** *Remote Sensing and Image Interpretation*, Lillesand, Kiefer, and Chipman (John Wiley and Sons, Fifth Edition)

Course Description and Purpose:

Remote sensing is the gathering of information without actual physical contact with what is being observed. In the earth sciences, this usually involves the use of photography, electronic spectroscopy, or radar to detect and differentiate surface materials.

Digital Imagery in the Geosciences is an introductory course in remote sensing. Emphasis is on general remote-sensing principles, including aspects of the nature of electromagnetic radiation, the spectral-response curves of earth materials, and a review of remote-sensing sensors and orbiting platforms. Numerous basic image-processing techniques are covered in this course, including image enhancement, image georeferencing, and image classification. Topics such as planetary remote sensing and the use of remotely-sensed topography in the study of terrestrial surface processes will also be covered.

No previous experience in remote sensing is assumed, although students are expected to have basic skills in computer usage and to have completed introductory mathematics courses at the first-year level. The main software package used in this course is *PCI Geomatica*.

Expected Learning Outcomes:

1) Students will have a basic understanding of fundamental remote sensing concepts such as the electromagnetic spectrum, blackbody radiation, atmospheric windows, and spectral response curves.
2) Students will have a general appreciation for the history of development of photographic and digital remote sensing technology.
3) Students will have an understanding of the different types of digital remote-sensing sensors, including the major optical, thermal, and microwave remote sensing systems that are presently operational.
4) Students will understand how to apply basic principles of digital image processing toward the extraction of information from remote-sensing databases; these principles include those of image enhancement, query, filtering, georeferencing, classification, and arithmetic.
5) Students will be exposed to basic methods of processing of remotely-sensed topographic databases.
6) Students will appreciate the practical value of remote sensing in the study of the Earth as well as in the exploration of other solar system bodies.

Criteria for Grading:

Assessments of learning will be based on three exams and eight (8) lab exercises. Additionally, there will be an optional comprehensive makeup exam that can replace one of the regular exams (e.g., for those who missed an exam earlier in the term, or for those who wish to try to improve their final grade by replacing their poorest exam result with a better result); the makeup exam will cover *all* material covered in the semester. Exams will be based on materials presented in the lectures, labs, and assigned readings. There is no final exam.

Exams will consist of multiple choice questions, fill-in-the-blank questions, and short-answer questions. Multiple-choice sections of exams will be computer scantron graded.

In addition to exams and discussion of exam results, assessments of learning will be made throughout the semester on the basis of periodic non-graded quizzes, and through discussion in labs and lectures. The final course grade will be based on A) the best 3 exam results, with each exam worth 20% of the final grade (total = 60% of final grade); and B) the 8 lab exercises, with each lab worth 5% (total = 40% of final grade); unless otherwise noted these exercises will be due one week after the relevant lab, and will be penalized 20% per late day.

The grading scale is as follows: *A* (90-100%); *B* (75-89.99%); *C* (60-74.99%);*D* (50-59.99%); *F* (0-50%).

GEOL 5342 SPATIAL DATA ANALYSIS AND MODELING IN GEOSCIENCES (3 credit hours)

Faculty Information:

Dr. Seiichi Nagihara Dept. of Geosciences seiichi.nagihara@ttu.edu

Course Information:

- **Prerequisites:** GEOL 3428/5428 or GEOG 3300/5300, and Statistical Methods (MATH 2300) or equivalent
- **Required Text**: *An Introduction to Applied Geostatistics,* E.H. Isaaks and R.M. Srivastava, Oxford University Press (**required**)
  Data in Three Dimensions: A Guide to ArcGIS 3D Analyst, H. Kennedy, OnWord Press (**required**)

Course Description and Purpose:

In this course, students will learn advanced techniques in GIS-based data interpretation, statistical analyses, and geospatial modeling. It is designed for researchers and practitioners who deal with a large volume of geologic, atmospheric, and other environmental data sets. The fundamental theories behind the analytical and modeling techniques are covered in detail. The theoretical knowledge will be enforced by a series of computer exercises, using real geological and environmental data. *ArcGIS* (Environmental Systems Research Institute, Inc.) and its extensions (*Geostatistical Analyst, Spatial Analyst,* and *3-D Analyst*) will be the primary GIS software tool for the exercises. We will also use *Microsoft Excel* for exercises in statistics.

Course Outline:

Expected Learning Outcomes:

1. To determine basic geospatial relationship (direction, distance, area size, elevation/altitude, volume etc.) of objects displayed in 3-D perspectives on computers.

2. To produce maps in 3-D perspectives on computers, if given necessary geospatial datasets.

3. To perform univariate and bivariate statistical analyses applied to geographically referenced data.

4. To understand the fundamental theories of spatial interpolation.

5. To perform surface interpolation of geographically reference data.

6. To perform model simulations on hydrologic processes.

Criteria for Grading:

Students will be graded on their performances in four sets of homework assignments. Each assignment must be turned in by the prescribed deadline. Each assignment consists of technical questions related to the course material covered and computer exercises.

	Time Allowed	Percentage contribution to the Final Grade
HW1	2.5 weeks	25%
HW2	2.5 weeks	25%
HW3	2.5 weeks	25%
HW4	2.5 weeks	25%

Grade Breakdown A (≥85%), B (≥70%), C (≥ 55%), D (≥40%), F (<40%)

Class Attendance:

Attendance is required although not part of the final grade.

NRM 5310 ADVANCED RANGE ECOLOGY (3 credit hours)

Instructor: Robert D. Cox
Office 09C, Goddard Building
742-2841 (Office)
Office Hours: 9:30-12:30 Monday, Wednesday, Thursday
or by appointment

Course Purpose:

An in-depth exploration of plant ecology theories and their application to the species and community levels. Individual environmental parameters and the plant's and community's response to these parameters will also be discussed, particularly as relating to arid and semi-arid environments and rangelands.

Expected Learning Outcomes:

At the end of the course, students should:

A. Understand how the history of plant ecological theory informs our current understanding:
Trace the development of ecological thought through time, and how discuss how one's background and experiences may influence their ecological thought.
Recognize major ecologists working today, as well as some of the ecologists who have influenced modern ecological thought.

B. Understand major plant communities of the world, with special focus on the United States:
Be able to recognize the major plant communities of North America and their geographical location.
Be able to describe the dominant plants, soils, and climate regime of each major plant community.

C. Understand the basics of prevailing world climates and climate change.
Describe the distribution of world climates and the causes of major climatic patterns.
Be able to associate specific plant formations with specific climatic regimes.
Understand the importance of climate and weather in influencing plant communities.

D. Be familiar with the environmental complex and selection of ecotypes best suited to particular environments:
Describe how the complexity of the environment, including climates and soils, influences plant communities and species.
Describe the adaptability of ecotypes to specific environmental regimes.

E. Understand resource allocation in plants as a response to varying environmental factors and management implications:
Be able to describe resource (i.e., energy) allocation in plants.
Define how plants are capable of responding to environmental cues and changing regimes.
Understand r- and k- selected life history patterns and their ecological relationships.

F. Understand how plants interact with each other:
Be able to describe different types of plant-plant interactions and how each interacting member in affected.
Describe how plant interactions influence community development.

G. Gain a thorough understanding of plant succession:
Differentiate between primary and secondary succession.
Understand serial and climax stages.
Understand different models of community succession and change.

H. Understand energy budgets, energy relations, and water use by native plants:
Understand energy budgets and the inter-relationships of energy budget components
Understand plant responses to high and low temperatures.
Understand light influences on the vegetation, and how the vegetation influences the light within the community.
Understand C3, C4, and CAM photosynthetic pathways and their ecological relationships.
Understand water potentials and transpiration in natural environments.

NRM 5322 ADVANCED NONGAME ECOLOGY AND MANAGEMENT (3 credit hours)

Faculty Information:

Dr. Clint Boal Office - 218 Agriculture Sciences clint.boal@ttu.edu

Course Information:

- **Prerequisites:** NRM 2301 or consent of instructor
- **Required Text:** Assigned readings only. Copies of assigned readings will be placed on reserve.

Course Description and Purpose:

Wildlife Management in North America was originally based on game management. Evolving social viewpoints, improved understandings of biotic community health and ecosystem stability, the value of biodiversity, and shifting social attention on non-consumptive uses of wildlife resulted in nongame conservation and management. This course introduces graduate students to the issues relating to nongame species and their conservation. We will briefly review basic principles of wildlife management for a common frame of reference. We will then survey selected species and species groups, their environments, the conservation issues facing them, and management approaches taken. The semester will draw heavily on assigned readings followed by discussions. Quizzes will follow assigned readings.

Course Outline:

Month	Day	Topic	Assigned Readings	
Jan	12	Nongame Intro		
Jan	17	Who manages wildlife		
Jan	19	**No class**		
Jan	24	Legislation		
Jan	26	Endangered Species Act	Morrow et al. 2004,	**Quiz**
Jan	31	Wolves of Yellowstone	Handout	
Feb	2	Populations	Caughley and Sinclair Chp 4	**Quiz**
Feb	7	Conservation Genetics		
Feb	9	Monitoring Overview	Handout	
Feb	14	**EXAM I**		
Feb	**16**	**TWS Meeting**	**no class**	
Feb	21	Bird Migration		
Feb	23	Passerine Bird Declines		
Feb	28	Fragmentation studies	Franklin et al. 2002, Faaborg 2002	**Quiz**
Mar	2	NA birds	Askins Chp 2&3	**Quiz**
Mar	7	NA birds	Askins Chp 5&6	**Quiz**
Mar	9	NA birds	Askins Chp 8&9	**Quiz**
Mar	**14**	**Spring break**	**no class**	
Mar	**16**	**Spring break**	**no class**	
Mar	21	Raptors	TBA	**Quiz**
Mar	23	**EXAM II**		
Mar	28	Amphibian&Reptiles	Semlitsch 2000	**Quiz**
Mar	30	Amphibian&Reptiles	TBA	
Apr	4	Focus: *Atrox*	Beaupre and Duvall 1998, Fitzgerals and Painter 2000	**Quiz**
Apr	6	Mammals	Mattson 2004, Nie 2004	**Quiz**
Apr	11	Focus: *Chiroptera*	Grad Presentation	
Apr	13	Focus: *Urocyon & Vulpes*	Grad Presentation	
Apr	18	Focus: *Dipodomys*	Grad Presentation	
Apr	20	Urban Wildlife	Bolen and Robinson Ch 17	**Quiz**
Apr	25	Urban Wildlife	Gehrt 2004, Mannan and Boal 2004	**Quiz**
Apr	27	Wildlife Rehabilitation	TBA	
May	**2**	**Last Day**		

Although this is not a writing intensive course, **it is reading and discussion intensive**.

Expected Learning Outcomes:

1. Demonstrate an understanding of basic wildlife management history and principles and how they relate to nongame species conservation. This will include:
    - The history of wildlife management and legislation in the United States
    - Population growth and limitations
    - Influences of habitat and habitat change
    - Community structure and dynamics
2. Demonstrate an understanding of basic monitoring and inventory methods, and the inherit biases, used for nongame birds, mammals, reptiles and amphibians.
3. Demonstrate an understanding of causes of declines of selected North American nongame bird species in different environments, and the conservation approaches taken.
4. Demonstrate an understanding of migration ecology, and the conservation issues concerning bats and neotropical migrant birds.
5. Demonstrate an understanding of conservation issues concerning North American reptiles and amphibians.
6. Demonstrate an understanding of conservation issues, causes, and management approaches concerning declining species of selected North American nongame mammals

Criteria for Grading:

Exams will be from lecture notes, presentations, videos, and reading assignments. All exams will be comprehensive. Point values are as listed below.

Assignments and Exams	**Points**	**% of grade**	**Points**	**Letter Grade**
Exam I	100	22	405	= A
Exam II	100	22	360	= B
Final Exam	150	33	315	= C
Class Project (Individual Component)	50	11	270	= D
Class Project (Total Project)	25	6	< 270	= lets not go there
Assigned Lecture	25	6		
Total Points Available	450	100		

Meeting: Each student will schedule a 10 minute meeting with the instructor prior to the first exam.
Quizzes: Quizzes will be given following 12 reading assignments. The lowest 2 scores will be dropped.

Class Attendance:

Class attendance is expected. Excessive absences (>3/month) without discussion with the instructor is grounds for dropping you from the class. In the event of excessive absences, the student must visit the instructor to discuss his or her status in the course. If the drop occurs before the 45th class day of the long semester or the 15th class day of the summer term, the instructor will assign a grade of W (see sections on dropping a course and on withdrawal). If the drop occurs after that time period, the student will receive a grade of F. This drop can be initiated by the instructor but must be formally executed by the academic dean. In extreme cases the academic dean may suspend the student from the university.
Make-up exams: Make-up exams will usually not be given. Arrangements must be made with the instructor in advance. If you do not do so, you will receive 0 points for that exam.

NRM 5404 AERIAL TERRAIN ANALYSIS (4 credit hours)

Faculty Information:

Dr. Ernest B. Fish Office - Room 102B Goddard Building ernest.fish@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** Campbell, J. B. 2002. Introduction to Remote Sensing. Third Edition. Guilford Press. New York, New York. 620 pp.
  Wanless, H. R. 1973. Aerial Stereo Photographs. Hubbard Press. Northbrook, Illinois. 92p.

Course Description and Purpose:

To provide the student an introductory knowledge of the principles of photogrammetry, geographic information systems, global positioning systems, and fundamentals of aerial photograph reading, interpretation, and evaluation with emphasis on and application to the management of renewable natural resources.

Course Outline:

I. Introduction
- A. Historical Background
- B. Terminology

II. Factors Influencing the Aerial Photograph
- A. The Aerial Camera
- B. The Camera Mounting
- C. Filters
- D. The Film
  1. General Film Construction
  2. Film Processing and Printing
- E. Atmospheric Conditions
- F. Surficial Characteristics
  1. Optical Properties
  2. Physical Properties

III. Characteristics of Aerial Photographs
- A. Vertical Photographs
  1. Scale
  2. Effective area
  3. Marginal Information
  4. Radial Displacement
  5. Flight Planning
- B. Oblique Photographs
  1. Types
  2. Scale
  3. Uses

IV. Stereoscopy - Stereoscopic Study of Aerial Photographs
- A. Properties of Human Vision
- B. The Stereoscopic Image
- C. Parallax
- D. Types of Stereoscopes
- E. Pseudoscopic Images
- F. Preparation for Stereoscopic Viewing

V. Basic Photogrammetric Techniques
- A. Radial Line Triangulation
  1. Theory
  2. General Methodology
  3. Types of Templates
  4. Radial Planimetric Plotter
  5. Sketchmaster Devices
- B. Topographic Mapping
  1. Techniques
  2. The Kelsh Plotter

VI. Characteristics of Digital Imagery
- A. Sensor Systems
  - 1. Landsat
  - 2. SPOT
- B. Digital Image Analysis
  - 1. Manual
  - 2. Computer Assisted

VII. Geographic Information Systems (GIS)
- A. Theory
- B. Applications and Examples

VIII. Global Positioning Systems (GPS)
- A. Theory
- B. Applications and Examples

IX. General Principles of Photo-Interpretation
- A. Introduction
- B. Diagnostic Characteristics of Images
- C. Photo-Interpretation Aids

X. Integrated Photographic Interpretation Applications
- A. Introduction
- B. Geographic Considerations
- C. Geologic Considerations
- D. Geomorphic Considerations
  - 1. Landform Analysis
  - 2. Drainage Pattern Analysis
  - 3. Soil Considerations
- F. Vegetative Considerations
- G. Hydrologic Considerations
- H. Land Use Considerations

Expected Learning Outcomes:

1. To provide the student with a perspective of the historical development and current status of the fields of photogrammetry and photo interpretation.
2. To provide the student with a basic knowledge of the factors influencing the quality characteristics of aerial photography.
3. To provide the student with a basic understanding of photogrammetric principles and operations
4. To provide the student with a basic understanding of photo image interpretation principles and their specific applications in various areas of study
5. To provide the student with a basic understanding of digital image analysis.
6. To provide students with a basic understanding of Geographic Information Systems (GIS) and current GIS technology.
7. To provide students with a basic understanding of Global Positioning Systems (GPS) and current GPS technology.

Criteria for Grading:

Graded material will consist of 2 mid-term exams and a final exam all of which carry an equal weight and are comprehensive in nature (100 points each). Additionally, laboratory exercises will be graded and there will be laboratory quizzes which are unannounced. These exercises and quizzes usually constitute approximately 200 points. Total point accumulation for the entire course is normally 550-650.

Letter grades for the course are based upon the following percentage categories applied to the total available number of points during a semester. Student must pass the final exam to receive a passing grade for the course.

A	**90-100**
B	**80 - 90**
C	**70 - 80**
D	**60 - 70**
F	**<60**

NRM 6303 IMAGERY INTERPRETATION FOR NATURAL RESOURCE (3 credit hours)

Faculty Information:

Dr. Ernest B. Fish Office - Room 9 Goddard Building ernest.fish@ttu.edu

Course Information:

- **Prerequisites:** RWFM 4403 or RWFM 5404 or equivalent course
- **Required Text:** Campbell, J. B. 1996. Introduction to Remote Sensing. Second Edition. Guilford Press. New York, New York. 622 pp.
  Wanless, H. R. 1973. Aerial Stereo Photographs. Hubbard Press. Northbrook, Illinois. 92p.

Course Description and Purpose:

To provide the student knowledge of geographic information systems, remote sensing imagery systems and fundamentals of imagery reading, interpretation, and evaluation with emphasis on and application to the management of renewable natural resources.

Course Outline:

I. Introduction
  A. General
  B. Review of Photogrammetric Principles
    1. Scale determinations and horizontal measurements
    2. Height determinations
      a. Single vertical photographs
      b. Vertical stereo pairs
    3. Area determinations
    4. Stereoscopy
      a. Airbase
      b. Stereoscope focal length
      c. Flying height
      d. Camera lens focal length
      e. Preparation for stereo viewing

II. Principles and Theories of Image Interpretation
  A. Levels of examination
    1. Image reading 2. Image analysis 3. Image interpretation
  B. Diagnostic characteristics of images
    1. Shape or configuration 2. Shadow 3. Tone, shade, color contrast 4. Pattern 5. Texture
    6. Surroundings or association 7. Size
  C. Levels of detail
    1. Reconnaissance 2. Semi-detailed 3. Detailed
  D. Interpretation Sequence
    1. Data collection 2. Synoptic overview 3. Preliminary interpretation 4. Detailed interpretation
    5. Formation of conclusions
  E. Miscellaneous considerations
    1. Backgrounds 2. Training 3. Experience

III. Imagery Producing Systems
  A. Photographic
    1. Black and white
      a. General photographic theory
      b. Photographic properties
        (1) Sensitometric
        (2) Image structure
          Color
          Color theory
          Photographic properties
    3. Color infrared
      a. Infrared theory
      b. Photographic properties
    4. Black and white infrared
  B. Thermal Imagery
    1. Thermal theory 2. System functions 3. Image characteristics

C. Radar (S.L.A.R.) Imagery
1. Radar theory 2. System functions 3. Image characteristics
D. Multispectral Scanners
1. Multispectral theory
2. System functions
3. Data characteristics
a. Imagery
b. Electromagnetic

IV. Digital Image Analysis
A. Manual
B. Computer assisted
1. Statistics extraction 2. Display alternatives 3. Image enhancement 4. Thematic extraction

V. Geographic Information Systems
A. Characteristics
B. Applications

VI. Global Positioning Systems (GPS)
A. Theory and Characteristics
B. Applications and Examples

VII. Integrated Interpretation and Applications
A. General
B. Agricultural Applications
1. Soils mapping
2. Land use classification
3. Land capability classification
4. Erosion surveys
5. Salinity surveys
6. Irrigation surveys
7. Crop yield surveys
8. Crop stress detection
C. Forestry, Botany, Ecology Applications
1. Temperate zone forestry 2. Tropical zone forestry 3. Botany - Ecology
D. Urban and Regional Studies Applications
1. Urban planning 2. Urban operations 3. Regional planning 4. Regional operations

VIII. Summary

Expected Learning Outcomes:

8. To provide the student with a perspective of the historical development and current status of the field of remote sensed imagery.
9. To provide the student with a basic knowledge of the factors influencing the quality characteristics of remote sensed imagery.
10. To provide the student with a basic understanding of image interpretation principles and their specific applications in various areas of study.
11. To provide the student with a basic understanding of digital image analysis.
12. To provide the student with a basic understanding of Geographic Information System technology.
13. To provide students with a basic understanding of Global Positioning Systems (GPS) and current GPS technology.

Criteria for Grading:

Graded material will consist of 2 mid-term exams and a final exam all of which carry an equal weight and are comprehensive in nature (100 points each).

NRM 6305 GEOSPATIAL TECHNIQUES IN NATURAL RESOURCE (3 credit hours)

Faculty Information:

Dr. Ernest B. Fish Dept. of Natural Resources Management

Course Information:

- Prerequisites: None
- Required Texts: -Chrisman, Nicholas. 1997. Exploring Geographic Information Systems. John Wiley and Sons, Inc. New York. 298p.
  -Ormsby, T., E. Napoleon, R. Burke, C. Groessl and L. Feaster. 2004. Getting to know ArcGIS desktop: basics of ArcView, ArcEditor, and ArcInfo. 2nd ed., updated for ArcGIS 9. ESRI Press. Redlands, California.
- Course Purpose: To provide the student an introductory knowledge of the principles of Geographic Information Systems and Global Positioning Systems. Applications for natural resource inventory, planning, and management will be emphasized.

Course Objectives:

1. To provide the student with a perspective of the historical development and current status of Geographic Information Systems and Global Positioning Systems technologies.

Expected Learning Outcomes:

a. Be able to define and understand the specific technical terminology involved in the fields of Geographic Information Systems and Global Positioning Systems.
b. Be able to identify suitable applications for Geographic Information Systems and/or Global Positioning Systems for the solution of renewable natural resource management problems.

2. To provide students with a basic understanding of Geographic Information Systems (GIS) and current GIS technology.

Expected Learning Outcomes:

a. Be able to define and discuss the characteristics of a Geographic Information System.
b. Be able to demonstrate an application of a Geographic Information System in the practical solution of a natural resource planning or management situation.

3. To provide students with a basic understanding of Global Positioning Systems (GPS) and current GPS technology.

Expected Learning Outcomes:

a. Be able to identify and discuss the functional components of a Global Positioning System.
b. Be able to use Global Positioning Systems equipment in a practical solution of a natural resource planning or management situation.

Criteria for grade determination:

Graded material will consist of an hourly midterm examination and a final exam each worth 100 points. Additionally, laboratory exercises and quizzes will constitute approximately 200 points. 200 points are allocated to class attendance and class participation. Total point accumulation for the entire course is normally 600 points.

Letter grades for the course are based upon the following percentage categories applied to the total available number of points during a semester.

A	90 - 100
B	80 - 90
C	70 - 80
D	60 - 70
F	<60

PSS 5329 PRECISION AGRICULTURE (3 credit hours).

Faculty Information:

Dr. Stephen Maas Dept. of Plant and Soil Sciences stephen.maas@ttu.edu

Course Information:

- **Prerequisites:** None
- **Required Text:** None

Course Description and Purpose:

Introduction to site-specific management of agricultural crops emphasizing collection and use of geospatial information in performing variable-rate farming practices.

Expected Learning Outcomes:

At the completion of this course, the student should be able to:

1. Understand how to operate a GPS,
2. Understand how yield monitors work,
3. Understand how to sample a field for soil characteristics,
4. Understand how remote sensing can be used in site-specific farming,
5. Understand how to use a GIS for on-farm applications,
6. Understand how to use integrated pest management on a site-specific basis,
7. Understand how to use variable-rate equipment and autosteer.

Methods for Assessing Expected Learning Outcomes:

The expected learning outcomes for the course will be assessed with periodic class assignments and a final exam.

Course Assignments and Grading Procedures:

A. There will be several class assignments and a comprehensive final exam. The final exam may contain a variety of question types, including definitions, essay, and computational problems. The final exam is scheduled at the time specified by the University for this class.

B. Class assignments will consist of problems or exercises to be completed by the student.

Grades

Class Assignments (100 pts.) + Final Exam (100 pts.) = TOTAL (200 pts.)

Point Distribution

A =	200 – 180	(90-100%)
B =	179 – 160	(80-89%)
C =	159 – 140	(70-79%)
D =	139 – 120	(60-69%)
F =	0 - 119	(0-59%)

General Information:

A. No make-up exams will be given, except for University-approved absence.

B. Extra credit may be offered at the discretion of the Instructor.

C. "The University is committed to the principle that in no aspect of its programs shall there be differences in the treatment of persons because of race, creed, national origin, age, sex, or disability, and that equal opportunity and access to facilities shall be available to all. If you require special accommodations in order to participate, please contact the instructor. Students should present appropriate verification from "AccessTECH" located in the Counseling Center. No requirement exists that accommodations be made prior to completion of this approved University process." The URL for AccessTECH is http://www.accesstech.dsa.ttu.edu/default.asp

D. Integrity and professionalism are expected at this level of education. Collaboration on assignments other than as specified, as well as dishonesty on exams, will not be tolerated. The guidelines set forth by the University will be followed with any infraction.

E. Regular class attendance is encouraged.

PSS 5333 SOIL AND PLANT RELATIONSHIPS (3 credit hours)

Faculty Information:

Dr. Robert J. Lascano USDA-ARS, 3810 4th Street, Lubbock, TX r-lascano@tamu.edu

Course Information:

- **Prerequisites:** Must be approved by instructor.
- **Required Text:** Given the interdisciplinary nature of this course no specific text is assigned to this class. Pertinent reference material is photocopied and distributed to students. Students are encouraged to purchase the student version of MathCad to solve homework assignments.

Course Description and Purpose:

This class teaches students in agronomy and associated disciplines about the physical principles and concepts as they relate to transport of *water* and *energy* in a soil-plan atmosphere system. Emphasis is given to measurement techniques and instrumentation of environmental parameters. The following is a general guideline used for each lecture.

- Outline of each lecture will be given to students.
- A suggested reading will be given for each lecture.
- Assigned readings will be given for each lecture with a required summary
- Assignment of problems (homework).

This course is to familiarize students with the basic concepts related to productivity and water management of agricultural systems. In addition, students are given pertinent literature related to the subject matter and are asked to provide synthesis of several journal articles. These are assigned based on the student's interests and background. Parts of the subject matter are specific to the interest and needs of the students.

Course Outline:

This is outline is subject to change and is modified to the specific needs and interests of the students that take this class.

1. Introduction of Materials and Basic Concepts
   - Introduction of course, instructor and students
   - Explanation to students of examinations, term paper, assignments, grades, etc.
2. Basic Physical Concepts
   I. Explanation of basic physical concepts, definitions and units
   a. Work, Pressure, Power, Mechanics, Water Potential
   b. *S.I.* Units
   c. The concept of a *flux*
3. Scientific Principles and Measurement Techniques
   a. Accuracy vs. precision
   b. Error in measurement
   c. Spatial variability
   d. Significant digits
4. Soil Water and Related Terms and Different Measurement Techniques
   - Gravimetric and volumetric methods
   - Direct vs. indirect methods
   - Soil hydraulic properties, i.e., water potential and hydraulic conductivity
5. Measurement of Environmental Parameters (irradiance, air temperature and humidity,& wind speed).
   - Instrumentation
   - Concept and calculation of potential evapotranspiration
   - Weather networks and the use of PET to calculate daily values of evapotranspiration

6 — 7. Water and Energy Balance, and Calculation of Fluxes
   - Temperature, sensible heat
   - Humidity, latent heat
   - Radiation, radiant energy
   - Gaseous diffusion
   - Energy balance of a leaf

8 — 9. Soil-Water Balance of a Bare Soil (Concepts and Applications)
   - Law of conservation of matter
   - Inputs and outputs

- Integral form of the water balance equation
- Models of the soil water balance:
- General flow equation-Richard's equation
- Water Infiltration and evaporation from a bare soil

10. Energy and Water balance of a Soil-Plant System (Concepts and Examples)
    - Radiative energy transfer
    - Energy balance of the plant canopy
    - Energy balance of the soil surface
    - Root water uptake

11 — 12. Water Requirements of Crops and Irrigation
    - Precision farming (systems)
    - Variable rate technologies

13 — 14. Student Presentations
    - Oral presentations of term papers.

Expected Learning Outcomes:

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

A. Have a general understanding of the factors that affect the energy and water balance of bare soil and cropped surfaces.

B. Have analytical skills to take weather information and calculate the potential evapotranspiration in reference to water requirement of crops.

C. Quantitative understanding of soil water in relation to crop water requirements.

D. Be able to apply theoretical concepts to practical applications of factors that affect crop production.

Criteria for Grading:

A. **Weekly homework assignments**. In these assignments students must answer open-ended questions and solve problems related to the subject of the weekly lectures. Students are encouraged to correct mistakes and return assignment for further verification. Students are encouraged to work as a team as a means to understand and comprehend difficult concepts. These homework assignments represent 20% of the final grade. All homework assignments with no exception are due a week after (7 days) given out in class.

B. **Mid-term exam**. An open book take home exam is given on the material covered in the first half of the class. Several questions are open-ended to allow students to search for information not necessarily given in class. This exam represents 15% of the final grade.

C. Weekly reading assignments. Every week students are given 2-3 journal articles and they are requested to provide a critical synthesis or summary of the paper. This also allows student's to practice technical writing. These assignments are 15% of the final grade. All reading assignments with no exception are due a week after (7 days) given out in class**.**

D. Term paper and Presentation. Students are requested to write a short term paper on a subject matter of their choice that is related to the content of the course. Also, students give a 12-15 minute oral presentation to the class on their term paper. This term paper and oral presentation represent 20% of the final grade.

E. Final Exam. A comprehensive open book exam is given at the end of the class. This exam follows the same format as that of the mid-term exam and represents 15% of the final grade.

F. Attendance and Student in-class participation. Class attendance and in-class discussion is encouraged and expected of all students. This component represents 15% of the final grade.

Grades:

Class attendance and participation 15%
Homework assignments 20%
Reading assignments 15%
Mid-term (open book) 15%
Class presentation (written and oral report) 20%
Take-Home open book final exam 15%

PSS 5334 SOILS AND CROPS IN ARID LANDS (3 credit hours)

Faculty Information:

Dr. Kevin Bronson Office : Room 7,Texas A&M Res & Extn Cntr kevin.bronson@ttu.edu

Course Information:

- **Prerequisites:** Introductory Soils
- **Required Text:** No one specific, chapters from multiple books provided as pdfs

Course Description and Purpose:

Overview of the soils, climate, geography, and cropping systems of arid and semiarid regions of the world. Soil and crop management topics specific to dry regions and case studies from six arid/semarid countries are addressed..

Course Outline:

Introduction to arid/semiarid regions
Saline/sodic soil management
Water management
Nutrient management
Conservation tillage
Erosion and CRP
Soil carbon management
Precision agriculture
Animal waste management
Wastewater and biosolids
West Texas case study
Eastern Colorado case study
Western Australia case study
Israel Negev case study
Pakistan case study
Uzbekistan case study
Afghanistan case study

Expected Learning Outcomes:

Students should understand and be able to discuss the following topics:

Definition of arid and semiarid regions
Saline/sodic soils and management
Water management in arid/semiarid regions
Nutrient management in arid/semiarid regions
Conservation tillage in arid/semiarid regions
Erosion and CRP
Soil carbon management
Precision agriculture in arid/semiarid regions
Animal waste management in arid/semiarid regions
Wastewater and biosolids in arid/semiarid regions
West Texas soils and crops
Eastern Colorado soils and crops
West/Central Asia soils and crops
Western Australia soils and crops
Israel Negev soils and crops

Criteria for Grading:

25 % mid-term, 25 % final, 25 % term paper and presentation, 25 % class participation

Class Attendance:

Required, no more than two absences, read assigned readings before class

Appendix B:
FACULTY CVS

Dr. Vivian Allen

Education

-Ph.D. Louisiana State University. 1979. Agronomy. Minor: Animal Science.
-M. S. Louisiana State University. 1973. Agronomy. Minor: Animal Science.
-B.S. University of Tennessee, Martin. 1962. General Agriculture. Minor: Music.

Professional Experience

-Thornton Chair and Horn Professor. Department of Plant and Soil Science. Texas Tech University. 1995-present.
-Owner/Manager. Feliciana Farms. Huntland, TN. 1970-present.
-Professor. Department of Crop and Soil Environmental Sciences. Virginia Polytechnic Institute and State University. 1993-95.
-Associate Professor of Agronomy. Virginia Polytechnic Institute and State University. -1986-93.
-Assistant Professor. Virginia Polytechnic Institute and State University. 1980-86.
-Post-doctoral Fellow. Louisiana State University. 1980.
-Research Assistant. Louisiana State University. 1978-79.

Professional Service (selected examples)

-Former President, American Forage and Grassland Council. 1992-93.
-Former President, Crop Science Society of America. 2001-02.
-Current Chair, International Grassland Congress Continuing Committee. 2001-05.
-Board of Trustees, Agronomic Science Foundation. 2004-07.
-Baker Endowment Advisory Council Member. Iowa State University. 2004.

Principal Research Interests

-Forage production, management, and physiology with primary interest in forage quality and antiquality factors and animal response. Grazing, metabolism, and feeding trials with animals. Forage management and forage/livestock systems with emphasis on maximizing use of forages for animal production, nutrient management and recycling to enhance sustainability of the forage/livestock system, and integrating grazing animals into sustainable forage/livestock /cropping systems. Mineral imbalances in the soil/plant/animal system, especially as related to sulfur, nitrogen, aluminum, phosphorus, magnesium, copper and antiquality components of forages. Salinity tolerance of forage crops and use of forages to remediate saline and nutrient challenged land.

Selected Publications

-Allen, V. G., R. Heitschmidt, and L. E. Sollenberger. 2004. Grazing systems and strategies. *In*: Forages: Volume II. The Science of Grassland Agriculture. R. F. Barnes, C. J. Nelson, M. Collins, and K. J. Moore. (Eds.). Iowa State Press/Blackwell Publishing Company, Ames, Iowa. 6th Edition.
-Allen, V. G. and co-authors. 2004. 6th Annual field tour of an integrated crop/forage/livestock systems approach for the Texas High Plains. Project summaries and other related research studies. Field Day Report. Jun. 18.
-Cradduck, W. C., A. A. Hopkins, V. G. Allen, and P. Brown. 2004. Cool-season perennial grasses for the Southern Great Plains. Annual meeting of the Tri-Societies. Seattle, WA. Oct. 31 Nov. 4. CD-ROM.
-Allen, V. G. and K. R. Pond. 2004. Direct feeding of seaweed supplement to cattle and swine to enhance carcass quality. US Patent Number 6,689,376 B2. Date of Issue Feb. 10.
-Pond, K. R. and V. G. Allen. 2004. Reducing E. Coli content of beef. Australian Patent Number 2001232751. Date of Issue Jul 8.
-Allen, V. G., K. R. Pond, K. E. Saker, and J. P. Fontenot. 2004. Seaweed supplement diet for enhancing immune response in mammals and poultry. US Patent Number 6,764,691 B2. Date of Issue Jul. 20.

(Full CV at http://www.pssc.ttu.edu/personnel/vallen/VivienAllenCV.pdf)

Dr. Clint Boal

Education

-Ph.D. 1997. Wildlife Ecology. University of Arizona, Tucson, AZ. Dissertation Title: The Urban Environment as an Ecological Trap for Cooper's Hawks.
-M.S. 1993. Wildlife Ecology. University of Arizona, Tucson, AZ. Thesis Title: Food Habits of Northern Goshawks on the Kaibab Plateau.
-B.S. 1990. Renewable Natural Resources, University of Arizona, Tucson, AZ.

Professional Experience

-2000 - present: Assistant Leader, USGS Texas Cooperative Fish and Wildlife Research Unit
-2006 - present: Research Associate Professor - Wildlife Ecology, Texas Tech University, Lubbock, TX.
-2000 - 2006: Research Assistant Professor - Wildlife Ecology, Texas Tech University, Lubbock, TX.
-1998 - 2000: Post-doctoral Research Fellow, USGS Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota, St. Paul, MN.
-1997 - 1998: Research Assistant, University of Arizona, Tucson, AZ.

Professional Activities

-Board Member - Raptor Research Foundation 2007-present.
-Associate Editor - Journal of Raptor Research 2001 - 2006.
-Associate Editor - Journal of Wildlife Management 2002 - 2004.

Professional Affiliations

-Cooper Ornithological Society
-Raptor Research Foundation
-Society for the Conservation and Study of Caribbean Birds
-Society of Field Ornithologists
-Society of Southwestern Naturalists
-The Wildlife Society
-The Wildlife Society - Texas Chapter
-Wilson Ornithological Society

Selected Publications

-Boal, C.W., C.L. Haralson, and W.H. Howe. 2008. Status of Golden Eagles in the Texas panhandle. Journal of Raptor Research 42:220-224.
-Boal, C.W. 2008. Observations of an Antillean Crested Hummingbird attacking saddled anoles. Caribbean Journal of Ornithology 21:48-49.
-Mannan, R.W., R.S. Steidl, and C.W. Boal. 2008. Identifying habitat sinks: a case study of Cooper's hawks in an urban environment. Urban Ecosystems 11:141-148.
-Boal, C.W. and T.S. Estabrook. 2007. Occurrence and condition of migrating Swainson's thrushes in the British Virgin Islands. Wilson Journal of Ornithology 119:716-720.
-Giovanni, M.D., C.W. Boal, and H.A. Whitlaw. 2007. Prey use and provisioning rates of breeding ferruginous and Swainson's hawks on the southern Great Plains. Wilson Journal of Ornithology 119:558-569.
-Merriman, J.W., C.W. Boal, T.L. Bashore, P.J. Zwank, and D.B. Wester. 2007. Abundance of diurnal raptors in relation to prairie dog colonies: implications for bird aircraft strike hazard. Journal of Wildlife Management 71:811-815.
-Boal, C.W., D.E. Andersen, P.L. Kennedy, and A. Roberson. 2006. Northern goshawk (Accipiter gentilis) ecology in the Western Great Lakes Region. Studies in Avian Biology 31:128-136.

Dr. Kevin Bronson

Education

-Ph.D. Auburn University. 1989. Major: Soil Fertility.
-M.S. University of the Philippines at Los Banos. 1984. Major: Soil Fertility. Minor: Agricultural Economics
-B.S. University of Maryland. 1981. Major: Soil Science.

Professional Experience

-Associate Professor. Texas Tech University. 2003.
-Associate Professor. Texas A&M University. 2002-present.
-Chair. Cotton Precision Agric. Project. Texas A&M University. 2001-present.
-Assistant Professor. Texas A&M University. 1998-02.
-Adjunct Associate Professor. West Texas A&M University. 2002-present.
-Adjunct Assistant Professor. Texas A&M University. 1998-present.
-Affiliate Scientist. International Rice Research Institute. Manila, Philippines. 1995-98.
-Affiliate Assistant Professor. University of Philippines. 1995-99.
-Soil Chemist. Commonwealth Scientific and Industrial Research. Australia. 1994- 95.
-Associate Visiting Scientist. International Rice Research Institute. Manila, Philippines. 1992-94.
-Soil Scientist. USDA-ARS, Ft. Collins, CO. 1989-92.
-Faculty Affiliate. Colorado State University. 1989-92.
-Graduate Research Assistant. Auburn University. Auburn, Alabama. 1987-89.
-Soils Specialist. Soil and Water Division. Raleigh, NC. 1984-86.
-Biological Aide. National Agricultural Research Center. Beltsville, MD. 1980-81.
-Laboratory Assistant. West Virginia Soil Testing Laboratory. 1979-80.

Professional and Honorary Societies

-American Society of Agronomy
-Soil Science Society of America
-Soil and Water Conservation Society
-Gamma Sigma Delta
-Sigma Xi

Honors and Awards

-Dean's List. University of West Virginia. 1979.
-A. L. Smith Outstanding Graduate Student of the Year Award. Auburn University. 1998.
-Certification of Merit for Outstanding Performance. USDA-ARS. 1990.
-Editors Citation for Excellence in Manuscript Review. Soil Science Society of America. 2001.

Principal Research Interests

-Soil fertility.

Selected Publications

-Wheeler, T. A. and K. F. Bronson. 2004. Precision Agriculture: Tools of the Trade. Nemat. Mono & Perspect. 2:5-12.
-Bronson, K. F., C. L. Trostle, A. M. Schubert, and J. D. Booker. 2004. Leaf nutrients and yields of irrigated peanut in the Southern Plains: Influence of nitrogen, phosphorus and zinc fertilizer. Commun. Soil Sci. Plant Anal. 35 (7/8):1095-1110.
-Ping, J., C. J. Green, R. E Zartman, and K. F. Bronson. 2004. Exploring spatial dependence of cotton yield using global and local autocorrelation statistics. Field Crops. Res. 89:219-236. 7 -Bronson, K. F., T. M. Zobeck, T. T. Chua, R. S. Van Pelt, and V. Acosta-Martinez. 2004. Carbon and nitrogen pools of Southern High Plains grassland and cultivated soils. Soil Sci. Soc. Am. J. 68:1695-1704.
-Ping, J., C. J. Green, K. F. Bronson, R. E Zartman, and A. Dobermann. 2004. Identification of Relationships between Cotton Yield, Quality and Soil Properties. Agron. J. 96:1588-1597.

Dr. Perry Carter

Education

-Ph.D., Geography, Ohio State University, 1998
-M.A., Political Economy, University of Texas at Dallas, 1992
-M.A., Geography, University of Georgia, 1986
-A.B., Geography, University of Georgia, 1983

Professional Experience

-Spring 2004, I developed and taught an upper-level undergraduate course in "Social and Cultural Geography." I was the first faculty member in my department to teach the newly developed capstone course "Seminar in Geography"
-Fall 2003, I developed and taught an upper-level undergraduate course in "Economic Geography"
-Spring 2003, I developed and have twice taught an upper-level undergraduate course entitled "Introduction to Research in Human Geography"
-Summer-Fall 2001-4, Over the past six semesters I have taught seventeen sections of "World Regional Geography"
-Fall 2002, I developed and have twice taught an upper-level undergraduate course in "Urban Geography"
-Spring 2000, I developed and taught a graduate seminar entitled "Geographies of Consumption," University of Kentucky
-1995-1996, I have assisted in teaching four quarters of "Applications of Quantitative Methods in Geography I and II," The Ohio State University

Research Interests

-General interests include human, social, urban and economic geography. Specific interests include geographies of consumption, travel and tourism, space and its role in the construction of racial identity, geographic methodologies.

Courses Offered

-GEOG 2351: Regional Geography of the World
-GEOG 3351: Urban Geography
-GEOG xxxx: Human Geography
-GEOG xxxx: Geographic Methods

Selected Publications

-"Geography, Race, and Quantification" (The Professional Geographer, 61(3) 2009)
-"Imagining Plantations: Slavery, Dominant Narratives, and the Foreign Born" with David Butler and Owen Dwyer (Southeastern Geographer, 48(3) 2008)
-"Women's Work: The Home, the Workplace, and the Spaces Between" with David Butler (The Industrial Geographer, 5(2) 2008)
-"Colored Places and Pigmented Holidays: Racialized Leisure Travel" (Tourism Geographies, 10(3), August 2008)
-"Penumbral Spaces: Undecidable bodies and Mobile Identities in Nella Larsen's Passing," (Gender, Place, and Culture, 13(3), June 2006)
-"The Entwined Spaces of 'Race', Sex and Gender" with Tobie Saad (Gender, Place, and Culture 12(1), March 2005)
-"The Travails of the Independent African-American Travel Agent," with David Butler and Stan Brunn (The Annals of Tourism Research, 29(4), 2002)

Dr. Ted Cleveland

Education

-Ph.D. University of California, Los Angeles, 1989, Civil Engineering
-M.S. University of California, Los Angeles, 1987, Civil Engineering
-B.S. Humboldt State University, 1986, Environmental Resources Engineering

Professional Experience

-Associate Professor, TTU, August 1996
-Assistant Professor, TTU, August 1990
-Hydrogeologist, CH2M-Hill, Emeryville, CA, 1989-1990

Professional Service in Last Five Years

-Faculty Advisor, Student Chapter, American Society of Civil Engineers 1990-1994; 2006-present
Proposal Review Panel Member, USEPA/SBIR Program, Stormwater and Arsenic -Removal Technologies. 2002. Washington, D.C.
-Proposal Review Panel Member, USDA/SBIR Program, Industrial Applications of Agricultural Products. 1998-present. Washington, D.C.
-Advisory Trustee, Galveston Bay Foundation, 1992-present
-Environmental Institute of Houston, Advisory Board Member, 1996 - present
-Houston Teachers Institute, Advisory Board Member, 2006 – present

Selected Publications

-Cleveland, T.G., and A. Fashokun, 2006."Construction-Associated Solids Loads with a Temporary Sediment Control BMP." American Society of Civil Engineers, Journal of Construction Engineering and Management, Vol 132., No. 10, pp
-Cleveland, T.G., X. He, W.H. Asquith, X. Fang, and D.B. Thompson, 2006. "Instantaneous Unit Hydrograph Selection for Rainfall-Runoff Modeling of Small Watersheds in North and South Central Texas." American Society of Civil Engineers, Journal of Irrigation and Drainage Engineering, Vol. 132, No. 5, pp.
-Asquith, W.H., Roussel, M.C., Cleveland, T.G., Fang, Xing, and Thompson, D.B., 2006. Statistical characteristics of storm interevent time, depth, and duration for eastern New Mexico, Oklahoma, and Texas. U.S. Geological Survey Professional paper 1725, 299p.
-Cleveland, T.G., He, X., Fang, X., Thompson, D.B. 2006. "Instantaneous Unit Hydrographs for Small Watersheds in Texas using Digital Elevation Data and Particle Tracking" in Costal Hydrology and Processes, Singh, V.P., and Xu, Y.J. eds. Water Resources Publications, Highlands Ranch, CO. pp 3-14
-Cleveland, T.G., He, X., Fang, X., Thompson, D.B. 2006. "Regressions Relating Watershed Physical Characteristics to Unit Hydrograph Parameters for Rainfall-Runoff Modeling in Central Texas" Costal Hydrology and Processes, Singh, V.P., and Xu, Y.J. eds. Water Resources Publications, Highlands Ranch, CO. pp 465-478.
-Fang, X., Pradhan, P., Malla, R., Cleveland, T.G., and Thompson, D.B. 2006. "Estimating Time of Concentration for Texas Watersheds" in Costal Hydrology and Processes, Singh, V.P., and Xu, Y.J. eds. Water Resources Publications, Highlands Ranch, CO. pp 465-478.
-Williams-Sether, T., Asquith, W.H., Thompson, D.B., Cleveland, T.G., and X. Fang. 2004. Empirical, Dimensionless, Cumulative-Rainfall Hyetographs for Texas. U.S. Geological Survey Scientific Investigations Report 2004-5075, 138p.
-Asquith, W.H. Thomson, D.B., Cleveland, T.G., and X. Fang. 2004. Synthesis of Rainfall and Runoff Data Used for Texas Department of Transportation Research Projects 0-4193 and 0-4194. U.S. Geological Survey Open-File Report 2004-103, 50p
-Cleveland, T.G. and M. Smith. 2003. "Demonstration of Remote Wireless Access to a Database for Communicating Water Quality Data." Final Report. Environmental Health Division, Houston Department of Health and Human Services.
-Cleveland, T.G., Thompson, D.,Fang,X. 2003. Instantaneous Unit Hydrographs for Central Texas. Proceedings of Texas Section Spring 2003 Meeting, Corpus Christi, Texas.

Dr. Robert D. Cox

Education

-Sep 2006 Ph.D., Botany (Ecology and Conservation Biology) University of California— Riverside, CA. Dissertation: Ecology and Management of Rare Plants Following Exotic Invasions in Riverside County, California.

-Aug 2000 MS., Botany Brigham Young University— Provo, UT. Thesis: Experimental seeding of native species into crested wheatgrass and
cheatgrass monocultures in Tooele County, Utah.

-Dec 1997 BS., Conservation Biology (Emphasis in Zoology) Brigham Young University— Provo, UT

Professional Experience

-2008-pres Assistant Professor, Habitat Restoration Ecology, Department of Natural Resources Management, Texas Tech University

-2006- 2008 Post-doctoral Ecologist, Shrubland Ecology and Restoration Group, USDA Forest Service Rocky Mountain Research Station, Boise Lab

-2003- 2007 Research Assistant, Center for Conservation Biology University of California Riverside

-2003-2004 Teaching Assistant, Dept of Botany and Plant Science University of California Riverside

-2002-2003 Teaching Assistant, Dept of Botany and Plant Science University Of California Riverside

-2002 Associate Faculty. Dept of Biological Science Mt. San Jacinto Community College

-1999-2000 Field Ecology Class Teaching Assistant. Dept of Botany and Range Science, Brigham Young University

-1998-2000 Range Plant Ecology and Identification Class Teaching Assistant. Dept of Botany and Range Science, Brigham Young University

-1998-2000 Plant Identification Team Coach. Dept of Botany and Range Science, Brigham Young University

-1997-2000 Summer Ecology Technician. Directorate of Environmental Programs Dugway Proving Grounds

-1994-1998 Student Office Clerk. Scholarship Department Brigham Young University

Research Interests

- I am interested in community and restoration ecology, distribution and conservation of rare and endemic plant species, and ecology of invasive species. In research, I have focused on large-scale restoration experiments with practical applications. I've also researched landscape-scale factors contributing to the decline and loss of native plant communities and rare, endemic species.

Selected Publications

-Cox, R.D. and E.B. Allen. 2008. Stability of exotic annual grasses following restoration efforts in southern California coastal sage scrub. Journal of Applied Ecology 45:495-504.

-Cox, R.D. and E.B. Allen. Composition of soil seed banks in southern California coastal sage scrub and adjacent exotic grassland. Plant Ecology ("online first" publication DOI 10.1007/s11258-007-9383-9).

-Allen, E.B., R.D. Cox, T. Tennant, S.N. Kee, and D. Deutsman. 2005. Landscape restoration in southern California forblands: Response of abandoned farmland to invasive annual grass control. Israel Journal of Plant Science 53:237-245.

-Cox, R.D., and V.J. Anderson. 2004. Increasing native diversity of cheatgrass-dominated rangeland through assisted succession. J. Range Manage. 57:203-210.

Dr. Tina Delahunty

Education

-Ph.D., Geography, University of Florida, 2002
-M.A., Geography, Florida Atlantic University, 1998
-B.S., Natural Resource Planning, Humboldt State University, 1995

Professional Experience

-2005-present Assistant Professor - Dept. of Economics and Geography, TTU
-2004-2005 Visiting Professor - Dept. of Economics and Geography, TTU
-2003-2004 Geographer in Residence - Human Studies Division
-College of the Atlantic, Bar Harbor, ME
-2000-2002 Adjunct Faculty - Dept. of Geography and Geology
-Florida Atlantic University, Boca Raton, FL
-2002 Faculty – Broward Community College, FL
-2000-2002 Faculty – Palm Beach Community College, FL

Research Interests

-Landuse Change. Remote Sensing. Biogeography. Paleoecology. Phytogeography.

Courses Offered

-GEOG 1401: Physical Geography
-GEOG 2351: World Regional Geography
-GEOG 3301/5301: Remote Sensing of the Environment
-GEOG 3310: Environmental Change
-GEOG 4321: Biogeography

Publications

-Submitted. Roberts, Charles, and Delahunty, J.L. "Textural Classification of Historical Landsat Imagery: A model for large urban areas." American Society for Photogrammetry and Remote Sensing (ASPRS).
-Submitted. Roberts, Charles, and Delahunty, J.L.. "A Technique for Creating Animated Maps of Urbanized Areas Using Landsat Imagery." Applied Geography.
-Revised and resubmitted. Delahunty, J.L., and Phelps, Jack. "Landcover change and remote sensing in the classroom: An exercise to study urban growth." Journal of Geography. Manuscript ID: RJOG-2009-0020. Second author: Jack Phelps, Undergraduate student, TTU
-2009. Delahunty, J.L., Roberts, Charles, and Breary, Gillian. "ARVIDA and the Planned Sprawl of West Boca" The Florida Geographer. 40: 101-118.
-2009. Delahunty, J.L.. "Yew Tree Toponyms and their Connection to the Irish Landscape." The American Geographical Society's Focus on Geography. 51(4): 1-6.
-2009. Delahunty, Tina. "The Yew in Ireland." The Journal of the Irish Woodturners' Guild. 48(March): 22-24.
-2007. Delahunty, J.L.. "The Ethnobotanical History and Holocene Extent of Yew (Taxus baccata L.) on the Irish Landscape. Journal of Ethnobiology. 27(2): 204-217.
-2007. Delahunty, J.L., and Todd, Reese. "Cultivating Geography in Primary Schools." Association of American Geographers Newsletter. 42(8):13.
-2007. Todd, Reese, and Delahunty, J.L.. " 'A' is for Aerial Maps and Art." Social Studies and the Young Learner. 20(2):11-14.
-2007. Delahunty, Tina. "Exploring the landscape with second graders: Resources for Texas elementary school teachers." <http://www.depts.ttu.edu/exploringlandscapes/index.asp>.
-2006. Todd, Reese, and Delahunty, J.L.. "Aerial Imagery and Geography Literacy." Texas Alliance for Geographic Education. 2006-2007: 6-7.
-2005. Delahunty, J.L.. "Remote sensing as a tool for mapping and monitoring habitat: A case study of the St. Vincent Parrot (Amazona guildingii)." Caribbean Geography. 14(1):31-39.

Dr. Clifford B. Fedler

Education

-B.S. Agricultural Engineering, Iowa State University, 1979
-M.S. Agricultural Engineering, Iowa State University, 1981
-M.S. Civil Engineering, Iowa State University, 1981
-Ph.D. Agricultural Engineering, University of Illinois, 1985

Professional Experience

-Assistant Professor (1985-1990), TTU
-Associate Professor (1990-1991), TTU
-Associate Chair (1990-1991), TTU
-Associate Professor (1991-1997), TTU
-Professor (1997-present), TTU
-Research Assistant, Iowa State University (1979-1981)
-Lab Assistant, Iowa State University (1980-1981)
-Research Assistant, University of Illinois (1981-1985)

Scientific and professional societies of which a member

-American Society of Civil Engineers
-American Society of Agricultural Engineers
-American Society for Engineering Education
-World Aquaculture Society
-International Society for Epistecybernetics
-Water Environment Association of Texas
-Waste Environment Federation

Honors and awards

-TTU Dads and Moms Association Spencer A. Wells Faculty Award for Creative Teaching (1998);
-Engineer of the Year Award awarded by the Texas Section of the American Society of Agricultural Engineers (1997);
-Top Paper Award, Gulf/Southwest Regional Conference of the ASEE (1992);
-Halliburton Outstanding Teaching Award, College of Engineering, Texas Tech University (1990);
-Outstanding Professor of the Year Award, ASEE Student Branch, Texas Tech University (1990,1992);
-Recipient of two 1988 ASAE Top Paper Awards (annual award presented to authors of the top 2.5 percent of the published papers);
-Halliburton Outstanding Researcher Award, College of Engineering, Texas Tech University (1986);
-Outstanding Teacher, University of Illinois, (1981-1983).

Selected Publications

-Fedler, C.B. 2005. Recycling Water Saves Future Drinking Supplies. Vol. 46(2):50-56. BioCycle-Journal of Composting and Organics Recycling. The JG Press, Inc. Emmaus, PS 18049.
-Fedler, C.B., C.J. Green, B. Mueller, and P.R. Pearson. 2004. Denitrification for Land Applied Treated Wastewater. 12th Annual Texas On-Site Wastewater Treatment Research Council Conference. Pps. 273-287. March 2-3, 2004. Texas Natural Resource Conservation Commission. Austin, TX.
-Fedler, C.B. 2003. Improving Nitrogen Removal in Treatment Wetlands for Animal Waste Treatment. U.S. Department of Agriculture Natural Resources Conservation Service East Regional Technology Workshop. Syracuse, NY, 17-19 June 2003.

Dr. Ernest B. Fish

Education

-B.S. Forest-Range Management, Colorado State University, 1964
-M.S. Range Ecology/Statistics, Colorado State University, 1966
-Ph.D. Watershed Management/Statistics, University of Arizona, 1973

Professional Experience

-Laborer, U. S. Forest Service, Coconino National Forest, 1960
-Range Research Aide, State of Colorado, 1961
-Range Aide and Technician, U. S. Forest Service, 1963-4
-Range Conservationist, Soil Conservation Service, 1965
-Range Conservationist, Soil Conservation Service, 1966
-Graduate Teaching Assistant, Colorado State University, 1965-6
-Instructor, Colorado State University, 1966
-Instructor, University of Arizona, 1968-73
-Assistant Professor, Texas Tech University, 1973-7
-Associate Professor, Texas Tech University, 1977-81
-Interim Chairman, Texas Tech University, 1977-8
-Interim Assistant Dean, Texas Tech University, 1978-9
-Interim Chairman, Texas Tech University, 1982-3
-Ecologist, National Park Service, Anchorage, Alaska, 1985-6
-Interim Academic Coordinator, Texas Tech University, 1989-90
-Interim Chairman, Texas Tech University, 1997
-Associate Chairman, Texas Tech University, 1998-9
-Chairman, Texas Tech University, 1999-2008
-Professor, Texas Tech University, 1981-Pres.

Research Interests

-"My students and I are currently involved in interdisciplinary research programs encompassing environmental inventories, geographic information systems applications, land use analysis, and land management planning in the southwestern region of the United States. Much of this work is conducted in my role as Director of the Geospatial Technologies Laboratory."

Courses Taught

-NRM 3308, 4314, 4315, 4403, 5317, 5404, 6303, 6305

Service

-Currently serves as the Director of the Geospatial Technologies Lab.

Selected Publications

-Brenton, C. M., E. B. Fish, and R. Mata-Gonzalez. 2007. Macronutrient and trace element leaching following biosolids application on semiarid rangeland soils. Arid Land Research and Management 21(2):143-156.
-Rice, M. B., W. B. Ballard, E. B. Fish, D. B. Wester, and D. Holdermann. 2007. Landowner attitudes toward black bears in the Trans-Pecos Region of Texas. Human Dimensions of Wildlife 12:405-415.
-Jurado, P., D. B. Wester, and E. B. Fish. 2006. Soil nitrate-nitrogen dynamics after biosolids application in a tobosagrass desert grassland. Journal of Environmental Quality 35:641-650.
-Hall, D. L., M. R. Willig, D. L. Moorhead, R. W. Sites, E. B. Fish, and T. R. Mollhagen. 2004. Aquatic macroinvertebrate diversity of playa wetlands: the role of landscape and island biogeographic characteristics. Wetlands 24(1):77-91.
-Arzani, H., M. Zohdi, E. Fish, G. H. Zahedi Amiri, A. Nikkhah, and D. Wester. 2004. Phenological effects on forage quality of five grass species. Journal of Range Management 57(6):624-629.
-Kamler, J. F., W. B. Ballard, E. B. Fish, P. R. Lemons, K. Mote, and C. C. Perchellet. 2003. Habitat use, home ranges, and survival of swift foxes in a fragmented landscape: conservation implications. Journal of Mammalogy 84(3):989-995.

Dr. Jeff Johnson

Education

-2003 Ph.D. Agricultural Economics Texas Tech University
-2002 Master of Strategic Studies U.S. Army War College
-1981 Master of Agriculture Agricultural Economics Texas A&M University
-1975 Bachelor of Science Animal Science Texas A&M University

Professional Experience

-Sept 2005 – present

- Assistant Professor, Department of Agricultural and Applied Economics, Texas Tech University (50% appointment)
- Assistant Professor, Agricultural Economics, Texas AgriLife Research - Lubbock, (25% appointment).
- Managing Director, Farm Operations, Texas Tech University (25% appointment).

-April 1994 – Aug 2005 Managing Director, Farm Operations, Texas Tech University.
-July 1992 – Mar 1994 Farm Management Associate – Texas Agricultural Extension Service – Weslaco.
-July 1990 – July 1992 Owner – Agricultural Management Information Services
-Oct 1984 – July 1990 Program Coordinator – Stiles Farm Foundation – Texas Agricultural Extension Service
-June 1981 – Oct 1984 Financial Analyst – Petty Ranch Company – San Antonio, Texas

Teaching

-Farm and Ranch Management (junior level), Applied Optimization Methods (senior level) and -Environmental Economics and Policy Analysis (graduate level distance).
-Served as committee chairman or co-chairman for 3 PhD and 4 MS students.
-Served as committee member on 14 other graduate committees,
10 of which were Crop Science students.
-Served as advisor for 4 undergraduate research projects.

Research Interests

-Regional Policy Alternatives in Response to Depletion of the Ogallala Aquifer
Adoption and implementation of effective water conservation policies can extend the life of the Ogallala Aquifer in the Southern High Plains of Texas. The primary objective of this study is to analyze the impact of water conservation policy alternatives on the regional economy of the Southern High Plains of Texas.
-Integrated Cotton Production Systems for Optimizing Profitability in the TSHP
Recent technology advances for cotton production in areas of improved cultivars, irrigation technology advances, and pest management strategies have required changes in production practices. The primary objective of this study is to evaluate the farm level economic impacts associated with the widespread adoption of production approaches relating to cultivar selection, water and nutrient levels, irrigation technology, and pest management strategies.

Selected Publications

-Dudensing, J., J. Johnson, P. Johnson, and C. Villalobos. Grazing Alternatives in the Face of Declining Groundwater: A Case from the Southern High Plains of Texas. *Texas Journal of Agriculture and Natural Resources.* 2009.
-Johnson, J., P.N. Johnson, E. Segarra, and D. Willis. Water Conservation Policy Alternatives for the Ogallala Aquifer in Texas. *Water Policy* 11(2009) 537-552.
-Wheeler, E., B. Golden, J. Johnson, and J. Peterson. Economic Efficiency of Short-term Versus Long-term Water Rights Buyouts. *Journal of Agricultural and Applied Economics* (Volume 40, Number 2) 2008.
-Wheeler-Cook, E., E. Segarra, P. Johnson, J. Johnson, and D. Willis. Water Conservation Analysis: The Case of the Southern Ogallala Aquifer. *Texas Journal of Agriculture and Natural Resources.* 2009.
-Wilde, C., J. Johnson, and J. Bordovsky. Economic Analysis of Subsurface Drip Irrigation System Uniformity. *Applied Engineering in Agriculture.* In press.

Dr. Robert Lascano

Education

-Ph.D. Texas A&M University. 1982.
-M.S. Texas A&M University. 1977.
-B.S. Texas A&M University. 1974.

Professional Experience

-USDA-Agricultural Research Service: Physical Scientist – Southern Plains Area
-Research Leader: WEWC-Soil Physicist

Projects

-Soil Management for Sustainable Agricultural Systems That Prevent Wind Erosion and Enhance the Environment
-Managing Limited Irrigation and Rainfall for Crop Production in Semi-Arid Environments
-Sustaining Rural Economies Through New Water Management Technologies
-Big Spring - Federal Bureau of Prisons Support of Mutual Interest
-Deficit Irrigation Management to Conserve Ogallala Aquifer Water
-New Water Management Technologies to Sustain Rural Economies - TTU
-Managing Soil and Cropping Systems for Efficient Water Use
-New Water Management Technologies to Sustain Rural Economies - TAMU
-New Water Management Technologies to Sustain Rural Economies - WTAMU
-Deficit Irrigation Management to Conserve Ogallala Aquifer Water

Selected Publications

-Baker, J.T., Van Pelt, R.S., Gitz, D.C., Payton, P.R., Lascano, R.J., McMichael, B.L. 2009. Canopy gas exchange measurements of cotton in an open system. Agronomy Journal. 101(1):52-59.
-Lascano, R.J., Evett, S.R., Van Bavel, C. 2008. Evapotranspiration: Measured with a lysimeter vs. calculated with a recursive method[abstract]. American Society of Agronomy, Crop Science Society of America, Soil Science Society of America Joint Annual Meeting. October 5-9, 2008. Houston, Texas. Paper No. 703-2.
-Baker, J.T., Lascano, R.J., Gitz, D.C., Payton, P.R., Van Pelt, R.S., Garcia, R. 2008. An open system for measuring canopy gas exchange[abstract]. ASA-CSSA-SSSA Joint Annual Meeting. Houston, Texas. October 5-9, 2008. Abstract No. 779-4.
-Bufon, V., Lascano, R.J. 2008. Hydrus-3D simulations: Irrigation management strategies for the Texas High Plains[abstract]. American Society of Agronomy, Crop Science Society of America, Soil Science Society of America Joint Annual Meeting. October 5-9, 2008. Houston, Texas. Paper No. 534-12.
-Nelson, R., Lascano, R.J., Booker, J. 2008. Cicular planting patterns in dryland crops: Surface hydrology[abstract]. American Society of Agronomy, Crop Science Society of America, Soil Science Society of America Joint Annual Meeting. October 5-9, 2008. Houston, Texas. Paper No. 755-4.
-Pelletier, M.G., Schwartz, R.C., Evett, S.R., Mcmichael, B.L., Lascano, R.J., Gitz, D.C., Baker, J.T., Payton, P.R. 2008. Analysis of Coaxial Soil Cell. In: Agronomy Society of America, Crop Science Society of America, Soil Science Society of America Meeting, Oct. 6-8, 2008, Houston, TX. 2008 CDROM.
-Evett, S.R., Howell, T.A., Lascano, R.J., Tolk, J.A. 2008. Two- and one-layer implicit energy balance solutions compared with the one-layer explicit Penman-Monteith solution for evapotranspiration of alfalfa [abstract]. 2008 Joint Meeting of American Society of Agronomy, Soil Science Society of America, and Crop Science Society of America, October 5-9, 2008, Houston, Texas. Paper No.703-3. 2008 CDROM.

Dr. Colleen Ann Leary

Education

-B.S. Massachusetts Institute of Technology, 1970
-M.S. Massachusetts Institute of Technology, 1973
-Ph.D. University of Washington, 1978

Professional Experience

-Professor, Atmospheric Science, Texas Tech University, 1989-present
-Associate Professor, Atmospheric Science, Texas Tech University, 1983-1989
-Assistant Professor, Atmospheric Science, Texas Tech University, 1978-1983
-Meteorologist, Environmental Research and Technology, Inc., Lexington, MA, 1972-1974

Graduate Courses

-ATMO 5302 Weather, Climate, and Applications (for M.S. program in Interdisciplinary Science Teaching)
-ATMO 5320 Mesometeorology
-ATMO 5327 Radar Meteorology
-ATMO 5328 Synoptic Meteorology
-G PH 5310 Geophysical Fluid Mechanics

Other Departmental Activities

-Undergraduate advisor for students with a minor in Atmospheric Science

Recent Publications

-Teacher's manual for the 2nd edition of the current textbook *Meteorology* by Ackerman and Knox, published by Thompson Publishing Company, 2006. The teacher's manual is available and distributed by the publisher on-line.
-Leary, Colleen A., 2002: Clouds: Cumuliform, in Encyclopedia of Atmospheric Sciences, edited by Holton, Pyle, and Curry, 2002. Academic Press. This article was invited and peer-reviewed.

Current Participation in Professional Organizations

-American Meteorological Society, American Geophysical Union

Other Professional Activities

Reviews for Government Agencies

-Reviewed proposals by mail for the National Science Foundation
-Reviewed proposals for the ARM program of the U.S. Department of Energy
-Reviewed for the American Meteorological Society journal Monthly Weather Review
-In the spring of 2005 and 2007, participated in panel reviews at the National Science Foundation

Current Research Interests

-Boundary layer meteorology, radar meteorology, tropical mesoscale convective systems, shipborne Doppler weather radar observations, gravity waves

Awards

-American Meteorological Society, Editor's award for review of manuscripts, *Monthly Weather Review*, 2002.

Dr. Jeff Lee

Education

-Ph.D., Geography, Arizona State University, 1990.
-M.A., Geography, University of California, Los Angeles, 1984.
-B.A., Geography, University of California, Los Angeles, 1979.

Professional Experience

2009- Professor, Department of Economics & Geography, Texas Tech University
1994-09 Associate Professor, Dept. of Economics & Geography, Texas Tech University
1988-94 Assistant Professor, Dept. of Geography, Texas Tech University
1988 Instructor, Department of Earth Science, Palomar College
1987 Lecturer, Department of Geography, San Diego State University
1985-87 Research Associate, Arizona State University Planetary Geology Group
1984-85 Instructor, Department of Geography, Arizona State University
1984 Research Associate, Arizona Laboratory of Climatology

Research Interests

-Physical geography. Geomorphology. Arid Lands. Field methods. Aeolian processes, especially wind erosion as a natural process and human influences on wind erosion.
-Science education.

Courses Offered

-GEOG 1401: Physical Geography
-GEOG 3335: Field Seminar in Physical Geography
-GEOG 3310: Environmental Change
-GEOG 4301: Geomorphology in Environmental Management
-GEOG 5304: Advanced Physical Geography
-HONS 2305: Honors Seminar in Science
-I S 5301: The Nature of Science for Teachers

Professional Service

-Treasurer of the International Society of Aeolian Research
-Started and moderated GEOMORPHLIST, an e-mail distribution service, for the International Association of Geomorphologists, 1993-1999.
-Secretary/Treasurer and then President of the Geomorphology Specialty Group of the Association of American Geographers from 1997 to 1999.
-Co-organizer of ICAR5/GCTE-SEN Joint Conference (International Wind Erosion Conference), Texas Tech University, July 2002.
-Served as advisor for Multidisciplinary Science Masters Program, 2000-2006
-Advisor for the undergraduate Interdisciplinary Minor in Geographic Information Science
-Advisor for the "Environmental Evaluation" Interdisciplinary Master's Program

Selected Publications

-Lee, Jeffrey A., 2005, George Perkins Marsh*; Focus on Geography*, v.48, no. 3, p. 35-6.
-Lee, Jeffrey A., 2004, Explaining the Plagues of Egypt, *Skeptical Inquirer*, v.28, no. 6, p. 52-4.
-Lee, Jeffrey A., 2004, Charles Darwin and Thomas Henry Huxley, *Focus on Geography*, v. 47, no. 4, p. 34-36.
-Stout, J. E. and Lee, J. A., 2003, Indirect Evidence of Wind Erosion Trends on the Southern High Plains of North America; *Journal of Arid Environments* v. 55, p. 43-61.
-Lee, J. A. and Zobeck,, Ted M., eds., 2002, *Proceedings of ICAR5/GCTE-SEN Joint Conference*, International Center for Arid and Semiarid Lands Studies, Texas Tech University, Lubbock, Texas, USA Publication 02-2, 462 p.
-Lee, Jeffrey A., 2002, Louis Agassiz, *Focus on Geography*, v. 47, no. 2, p. 30-31.

Dr. David Leverington

Education

-1996-2001 Ph.D., Geological Sciences, Dept. of Geological Sciences, University of Manitoba, Winnipeg, Manitoba, Canada.
-1993-1995 M.Sc., Earth Science, Ottawa-Carleton Geoscience Centre, University of Ottawa, Ottawa, Ontario, Canada.
-1988-1992 B.A. (Hon.), Physical Geography, (Magna Cum Laude), Department of Geography, University of Ottawa, Ottawa, Ontario, Canada.

Professional Experience

-2005-pres. Assistant Professor (tenure track), Department of Geosciences, Texas Tech University, Lubbock, Texas.
-2001-2005. Postdoctoral Fellow, Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, DC.
-2001-2001. Postdoctoral Fellow, Dept. of Geological Sciences, University of Manitoba, Winnipeg, Manitoba, Canada.

Selected Publications

-Leverington, D.W., (in press), Discrimination of sedimentary lithologies using Hyperion and Landsat TM data: A case study at Melville Island, Canadian High Arctic, International Journal of Remote Sensing.
-Leverington, D.W., 2009, Reconciling channel formation mechanisms with the nature of elevated outflow systems at Ophir and Aurorae Plana, Mars, Journal of Geophysical Research, 114: E10005, doi:10.1029/2009JE003398.
-Leverington, D.W., 2007, Was the Mangala Valles system incised by volcanic flows?, Journal of Geophysical Research, 112, E11005, doi:10.1029/2007JE002896.
-Thompson, T.W., Campbell, B.A., Ghent, R.R., Hawke, B.R., Leverington, D.W., 2006, Radar probing of planetary regoliths: An example from the northern rim of Imbrium Basin, Journal of Geophysical Research, 111: E06S14, doi:10.1029/2005JE002566.
-Leverington, D.W., 2006, Volcanic processes as alternative mechanisms of landform development at a candidate crater-lake site near Tyrrhena Patera, Mars, Journal of Geophysical Research, 111, E11002, doi:10.1029/2004JE002382.
-Duguay, C.R., Zhang, T., Leverington, D.W., Romanovsky, V.E., 2005, Satellite remote sensing of permafrost and seasonally frozen ground, In Remote Sensing in Northern Hydrology: Measuring Environmental Change (C.R. Duguay and A. Pietroniro, Eds), Geophysical Monograph 163, American Geophysical Union, pp.91-118.
-Leverington, D.W., Moon, W.M., 2005, On the use of consensus algorithms to address variability in the results of neural network classifications: Preliminary tests involving two northern study areas, Canadian Journal of Remote Sensing, 31: 269-273.
-Clarke, G.K.C., Leverington, D.W., Teller, J.T., Dyke, A.S., Marshall, S.J., 2005, Fresh arguments against the Shaw megaflood hypothesis - A reply to comments by David Sharpe, Correspondence, Quaternary Science Reviews, 24: 1533-1541.
-Ghent, R.R., Leverington, D.W., Campbell, B.A., Hawke, B.R., Campbell, D.B., 2005, Earth-based observations of radar-dark crater haloes on the Moon: Implications for regolith properties, Journal of Geophysical Research, 110: E02005, doi:10.1029/2004JE002366.
-Leverington, D.W., 2004. Volcanic rilles, streamlined islands, and the origin of outflow channels on Mars, Journal of Geophysical Research, 109: E10011, doi:10.1029/2004JE002311.
-Leverington, D.W., Maxwell, T.A., 2004. An igneous origin for features of a candidate crater-lake system in western Memnonia, Mars, Journal of Geophysical Research, 109: E06006, doi:10.1029/2004JE002237.

Dr. Stephen Maas

Education

-Ph.D. Texas A&M University. 1985. Agronomy.
-M.S. Texas A&M University. 1975. Meteorology.
-B.S. Texas A&M University. 1973. Meteorology.
-Temple Junior College. Temple, TX. 1969-70.

Professional Experience

-Professor of Agricultural Microclimatology. Department of Plant and Soil Science. Texas Tech University. 2000 to present.
-Plant Physiologist. Agricultural Research Service. Western Integrated Cropping Systems Research Unit. U.S. Department of Agriculture. 1993-2000.
-Plant Physiologist. Agricultural Research Service. Remote Sensing Research Unit. U.S. Department of Agriculture. 1984-93.
-Graduate Teaching and Research Assistant. Department of Meteorology, Department of Soil & Crop Sciences. Texas A&M University. 1982-84.
-Meteorologist. Joint Appointment, Texas Agricultural Experiment Station and U.S. Department of Agriculture. 1980-81.
-Research Scientist. Blackland Research Center. Texas Agricultural Experiment Station. 1977-80.
-Senior Meteorologist. Meteorology Research, Inc. Altadena, California. 1975-77.
-Graduate Research Assistant. Department of Meteorology. Texas A&M University. 1973-74.
-Research Assistant. Blackland Research Center. Texas Agricultural Experiment Station. 1973.

Professional and Honorary Societies

-American Society of Agronomy (ASA)
-American Society for Photogrammetry and Remote Sensing (ASPRS)

Principal Research Interests

-Remote sensing, crop growth modeling, environmental factors affecting crop growth, precision agriculture, crop yield prediction.

Books and Book Chapters

1. Maas, S. J. 2003. Irrigation scheduling by remote sensing technologies. In B. A. Stewart and T. A. Howell (Eds.), Encyclopedia of Water Science. Marcel Dekker, New York, NY. pp. 523-527.
2. Moran, M. S., S. Maas, V. Vandebilt, S. Miller, and E. Barnes. Natural resources and environment: Irrigated agriculture. In S. L. Ustin (Ed.), Manual of Remote Sensing, Vol. 5. John Wiley and Sons, New York, NY. pp. 617-676.

Selected Publications

-Fitzgerald, G. J., S. J. Maas, and W. R. DeTar. 2004. Spider mite detection and canopy component mapping in cotton using hyperspectral imagery and spectral mixture analysis. J. Precision Agriculture. 5:279-289.
-Wanjura, D. F., S. J. Maas, D. R. Upchurch, and J. C. Winslow. 2004. Scanned and spot measured canopy temperatures of cotton and corn. Computers and Electronics in Agriculture. 44:33-48.
-Baez, A. D., J. Kiniry, S. J. Maas, M. Tiscereno, J. Macias, J. Mendoza, C. Richardson, J. Salinas G., and J. R. Manjarrez. 2005. Large-area maize yield forecasting using leaf area index based yield model. Agronomy Journal. 97(2):418-425.
-Ko, J., S. J. Maas, R. J. Lascano, and D. Wanjura. Modification of the GRAMI model for cotton. Agronomy Journal, accepted.
-Bronson, K. F., J. D. Booker, S. J. Officer, R. J. Lascano, S. J. Maas, S. W. Searcy, and J. Booker. 2005. Apparent electrical conductivity and soil properties in the Southern High Plains. J. of Precision Agric. 6:297-311.

(Full CV at http://www.pssc.ttu.edu/personnel/smaas/MaasCV.pdf)

Dr. Nancy E. MacIntyre

Education

-Ph.D. Ecology, Colorado State University, 1998
-M.S. Zoology, University of Georgia, 1993
-B.S. Zoology, University of Georgia, 1991

Professional Experience

-2006-Present: Associate Professor, Department of Biological Sciences, TTU
-Curator of Birds, Natural Science Research Laboratory, The Museum of TTU
-2005-Present: Environmental Consultant, Lubbock, TX
-2000 – 2006: Assistant Professor, Department of Biological Sciences, TTU
-1998 – 2000: Postdoctoral Research Associate, Central Arizona-Phoenix Long-Term
-Ecological Research Project, Arizona State University, Tempe, AZ
-1997 – 1998: Graduate Writing Fellow, Colorado State University, Fort Collins, CO
-1993 – 1997: Graduate Teaching Assistant, Department of Biology, Colorado State U.
-1992 – 1993: Graduate Research Fellow, University of Georgia, Athens, GA
-1992: Graduate Research Assistant, Savannah River Ecology Laboratory, Aiken, SC
-1991 – 1992: Graduate Teaching Assistant, Department of Zoology, U. of Georgia
-1990 – 1991: Laboratory worker, UGA Institute of Ecology Horseshoe Bend Program
-1990: Intern, Museum of Natural History, University of Georgia, Athens, GA

Awards

-1998 NASA-Michigan State U. Professional Enhancement Award in Landscape Ecology
-1997 University-wide Graduate School Dissertation Fellowship, Colorado State U.
-1996 Graduate Degree Program in Ecology Teaching Fellowship, Colorado State U.
-1996 Colorado Graduate Fellowship, Colorado State University
-1995 Graduate Degree Program in Ecology Teaching Fellowship, Colorado State U.
-1992 Graduate Teaching Assistant Merit Supplement, University of Georgia
-1992 University-wide Graduate Assistantship, University of Georgia
-1991 University of Georgia Department of Zoology Grace Thomas Award

Recent Courses Taught

-Community Ecology / Advanced Community Ecology
-Ecology of Arid and Semi-arid Lands
-General Ornithology / Advanced Ornithology
-Landscape Ecology / Advanced Landscape Ecology
-Metapopulation Biology
-Ornithological Curation Techniques
-Principles of Ecology (formerly Populations, Communities, and Ecosystems)

Selected Publications

-Bell, C.W., V.A. Martinez, N.E. McIntyre, S. Cox, D. Tissue, and J. Zak. 2009. Linking microbial community structure and function to seasonal differences in soil moisture and temperature in a Chihuahuan Desert grassland. Microbial Ecology 58:827-842. DOI: 10.1007/s00248-009-9529-5.

-Brunjes, K.J., W.B. Ballard, M.H. Humphrey, F. Harwell, N.E. McIntyre, P.R. Krausman, and M.C. Wallace. 2009. Home ranges of sympatric mule deer and white-tailed deer in Texas. Southwestern Naturalist 54:253-260.

-Holsomback, T.S., N.E. McIntyre, R.A. Nisbett, R.E. Strauss, Y.-K. Chu, A.A. Abuzeineh, N. de la Sancha, C.W. Dick, C.B. Jonsson, and B.E.L. Morris. 2009. Bayou virus detected in non-Oryzomyine rodent hosts: an assessment of habitat composition, reservoir community structure, and marsh rice rat social dynamics. Journal of Vector Ecology 34:9-21.

-McIntyre, N.E., R.A. Nisbett, A. Abuzeineh, T. Holsomback, Y.-K. Chu, J.A. Carmichael, N. de la Sancha, C.W. Dick, C.B. Jonsson, and R.D. Owen. 2009. Ecological correlates of serological status for Bayou virus in Oryzomys palustris (Rodentia: Sigmodontinae). Mastozoología Neotropical 16:83-93.

-Reece, B.A., and N.E. McIntyre. 2009. Community assemblage patterns of odonates inhabiting a wetland complex influenced by anthropogenic disturbance. Insect Conservation and Diversity 2:73-80. DOI: 10.1111/j.1752-4598.2008.00044.x.

Dr. Kevin Mulligan

Education

-Ph.D., Geography, Texas A&M University, 1997
-M.A., Geography, University of California, Los Angeles, 1985
-B.A., Geography, University of California, Los Angeles, 1979

Professional Experience

-Director, Center for Geospatial Technology
Texas Tech University, Lubbock Texas, 2005-present
-Associate Professor, Department of Economics and Geography,
Texas Tech University, Lubbock, Texas, 2005- present
-Assistant Professor, Department of Economics and Geography,
Texas Tech University, Lubbock, Texas, 1999- present
-Lecturer and Visiting Assistant Professor, Department of Geography,
Texas A&M University, College Station, Texas, 1996-98.

Research Interests

-Applied geospatial technologies (geographic information systems, remote sensing, GPS, geospatial database design, digital cartography, terrain visualization and Internet mapping).
-Arid and semi-arid environments. Desert geomorphology, hydrology and climate.
Aeolian processes. Field research methods and instrumentation in physical geography.

Courses Offered

-GEOG 1401: Physical Geography
-GEOG 3300/5300: Geographic Information Systems
-GEOG 3301/5301: Remote Sensing of the Environment
-GEOG 4302/5302: Advanced Geographic Information Systems

Selected Publications

-Barbato, L. S. and Mulligan, K. R., 2004, Automating Texas' first and largest underground water district: a well permit management application and database. *Proceedings, Twenty-Fourth Annual ESRI International User Conference*, San Diego, California (CD-ROM).
-Mulligan, K. R. and Fish, E. B., 2004, Mapping Playa Lake Basins on the Llano Estacado, Texas, *GIS – The Language of Geography*, ESRI Map Book, vol. 19, p. 22.
-Mulligan, K. R., DeBaca, R. S., Barbato, L. S. and Speer, J. B., 2004, West Texas Atlas of Rural and Community Health. *GIS – The Language of Geography*, ESRI Map Book, vol. 19, p. 58.
-Nagihara, S., Mulligan, K. R., and Xiong, W., 2004, Use of a three-dimensional laser scanner to digitally capture the topography of sand dunes in high spatial resolution. *Earth Surface Processes and Landforms*, vol. 29, 391-398.
-Mulligan, K. R., 2003, Feasibility of using satellite imagery to aid in the assessment of tornado damage. *Final Report, Windstorm Mitigation Initiative Year 4, Research Thrust C: Windstorm Economics*, National Institute of Standards and Technology (NIST), 33 p.
-Barbato, L. S., Mulligan, K. R., and Weinbeck, S., 2003, Distribution of Historical Tornadoes 1950-1995, *Geography and GIS – Serving Our World*, ESRI Map Book vol. 18., p. 30.
-Mulligan, K. R., and Tchakerian, V. P., 2002, Toward a genetic classification of aeolian sand dunes. In *Proceedings of the ICAR5/GCTE-SEN Joint Meeting (Fifth International Conference on Aeolian Research),* Lee, J. and Zobeck T.M. (eds.), International Center for Arid and Semiarid Lands Studies, Texas Tech University, Lubbock, Texas, Publication No. 02-2, p. 449.

Dr. Seiichi Nagihara

Education

-Ph.D. (Geological Sciences), University of Texas at Austin, 1992, Supervisors: John G. Sclater and Arthur E. Maxwell
-M.S. (Geophysics), Chiba University, Japan, 1987
-B.S. (Geophysics), Chiba University, Japan, 1985

Professional Experience

-7/87 - 5/92, Research Assistant, Institute for Geophysics, University of Texas at Austin
-5/92 - 6/92, Post-doctoral Fellow, Institute for Geophysics, University of Texas at Austin
-7/92 - 12/94, Postgraduate Research Geophysicist, Scripps Institution of Oceanography, University of California, San Diego
-1/95 – 8/00, Research Assistant Professor, Department of Geosciences, University of Houston
-1/99 – 8/00, Research Associate, Allied Geophysical Laboratory, University of Houston
-9/00 – 8/06, Assistant Professor, Department of Geosciences, Texas Tech University
-9/06 – present, Associate Professor (tenured), Department of Geosciences, Texas Tech University

Selected Publications

-Nagihara, S. in press, Characterization of the sedimentary thermal regime along the Corsair growth fault zone, Texas continental shelf, using corrected bottom-hole temperatures: Amer. Assoc. Petrol. Geol. Bull.
-Nagihara, S., and M. A. Smith, 2008, Regional overview of deep sedimentary thermal gradients of the geopressured zone of the Texas-Louisiana continental shelf: Amer. Assoc. Petrol. Geol. Bull., v. 92, p. 1-14.
-Nagihara, S., and K. O. Jones, 2005, Geothermal heat flow in the northeast margin of the Gulf of Mexico: *American Association of Petroleum Geologists Bulletin*, v. 89, p. 821-831.
-Nagihara, S., and M. A. Smith, 2005, Geothermal gradient and temperature of hydrogen sulfide-bearing reservoirs in the continental shelf off Alabama: *American Association of Petroleum Geologists Bulletin*, v. 89, p. 1451-1458.
-Nagihara, S., K. R. Mulligan, and W. Xiong, 2004, Use of a three-dimensional laser scanner to digitally capture the topography of sand dunes in high spatial resolution: Earth Surface Processes and Landforms, v. 29, p. 391-398.

Dr. Ken Rainwater

Education

-B.S. Civil Engineering, Rice University, 1979
-M.S. Civil Engineering, (water resources), The University of Texas at Austin, 1982
-Ph.D. (water resources), The University of Texas at Austin, 1985

Professional Experience

-Assistant Professor (1985-1991);
-Associate Professor (1991-2002);
-Joint Faculty, Department of Geosciences (1992-present); Professor (2002-present);
-Director, Texas Tech University Water Resources Center, (2002-present)

Professional societies

-American Society of Civil Engineers
-American Geophysical Union
-Association of Ground Water Scientists and Engineers Delegate
-Universities Council on Water Resources
-Diplomate, American Academy of Environmental Engineers

Honors and awards

-Ex-Students Association New Faculty Award, 1987
-Halliburton Education Foundation Research Award, 1987
-Tau Beta Pi Outstanding Professor Award, 1988
-Abell Faculty Teaching Award, College of Engineering, 1989, 2001
-President's Excellence in Teaching Award, 1990
-Zone III Faculty Advisor of the Year, American Society of Civil Engineers, 1996, 1998
-Texas Tech University Teaching Academy, 1996-
-Who's Who Among America's Teachers, 1998
-Department of Civil Engineering Teacher of the Year, 2000
-Service to Students Award, Texas Section, American Society of Civil Engineers, 2001
-Faculty Advisor Reward, American Society of Civil Engineers, 2001, 2002

Professional service in the last five years

-*Departmental committees* – ABET (chair), Scholarships (chair), Water resources faculty search (chair)
-*College committees* – Awards, Scholarships, ABET, External departmental tenure and promotion review
-*University committees* – Tenure hearing, Water initiative, Faculty book award
-*Professional* – Co-faculty advisor ASCE student chapter, reviewer of manuscripts (NGWA [associate editor], AGU, Bioremediation) and proposals (NSF, USGS, EPA)

Selected Publications

-Rainwater, K.A., Stovall, J.N., Frailey, S.M., and Urban, L.V., "Transboundary Impacts on Regional Groundwater Modeling in Texas," invited for special edition of *Ground Water*, NGWA, accepted, in press.
-Jackson, W.A., Anandam, S., Anderson, T., Lehman, T.M., Rainwater, K.A., Rajagopalan, S., Ridley, M., and Tock, W.R., 2005. "Occurrence of Perchlorate in the Texas Southern High Plains AquiferSystem," *Ground Water Monitoring and Remediation*, NGWA, Vol. 25, no.2, pp. 137-149.
-Rainwater, K.A., Jackson, W.A., Ingram, W., Lee, C.Y., Thompson, D.B., Mollhagen, T.R., Ramsey, R.H., and Urban, L.V., 2005. "Field Demonstration of the Combined Effects of Absorption and Evapotranspiration on Septic System Drainfield Capacity," *Water Environment Research*, Vol. 77, no.2, pp. 150-161.
-Williams, D.L., Timmons, J.C., Woodyard, J.D., Rainwater, K.A., Lightfoot, J.M., Richardson, B.R., Burgess, C.E., and Heh, J.L., 2004. "UV-Induced Degradation Rates of 1,3,5 Triamino 2,4,6 Trinitrobenzene (TATB)," *Journal of Physical Chemistry*, American Chemical Society, Vol. 107, no. 44, pp. 9491-9494.
-Jackson, W.A., Arunagiri, S., Tock, R.W., Anderson, T., and Rainwater, K.A., 2004, "Electrochemical Generation of Perchlorate in Municipal Drinking Water Systems," *Journal of the American Water Works Association*, Vol. 96, no. 7, pp. 103-108.

Dr. Phil Smith

Education

-Ph.D. Environmental Toxicology, Texas Tech University 2000
-M.S. Clemson University's Institute of Wildlife and Environmental Toxicology 1997
-B.S. Chemistry & Biology, Murray State University 1989

Professional Experience

-Associate Professor, Terrestrial Ecotoxicology, TTU, 2000-present
-Member of TTU Institute of Environmental & Human Health (TIEHH)

Research Interests

-Ecotoxicology
-Wildlife Toxicology

Classes

-ENTX 6371 Ecological Risk Assessment
-TOX 6115 Journal Club Seminar "Current Topics in Environmental Ecotoxicology"

Selected Publications

-Brausch, John M., Smith, Philip N. 2009. Development of resistance to cyfluthrin and naphthalene among Daphnia magna. Ecotoxicology. (accepted).
-Brausch, John M., Smith, Philip N. 2009. Mechanism determination for resistance and cross-resistance to agrochemicals in Thamnocephalus platyurus (Crustacea: Anostraca). Aquatic Toxicology. (accepted).
-Dinehart, Simon, Smith, Loren M., McMurry, Scott T., Anderson, Todd A., Smith, Philip N., Haukos, David A. 2009. Toxicity of a glufosinate- and several glyphosate-based herbicides to juvenile amphibians from the Southern High Plains. Science of the Total Environment. (in press).
-Brausch, John M., Smith, Philip N. 2009. Pesticide resistance from historical agricultural chemical exposure in Thamnocephalus platyurus (Crustacea:Anostraca). Environmental Pollution. 157:481-487.
-Cheng Qiuqiong, Liu, Fujun, Smith, Philip N., Jackson, W. Andrew, McMurry, Scott T., Hooper, Michael J., Smith, Ernest E., Blount, Benjamin C., Valentin-Blasini, Liza, Anderson, Todd A. 2008. Perchlorate Distribution, Excretion, and Depuration in Prairie Voles and Deer Mice. Water, Air, and Soil Pollution. 192:127–139
-Liu, Jun, Cox, Stephen B., Beall, Blake, Brunjes, Kristina J., Pan, Xiaoping, Kendall, Ronald J., Anderson, Todd A., McMurry, Scott T., Cobb, George P., Smith Philip N. 2008. Effects of HMX Exposure Upon Metabolic Rate of Northern Bobwhite Quail (Colinus virginianus) in ovo. Chemosphere. 71:1945-1949.
-Rainwater, Thomas R., Selcer, Kyle W., Nespoli, Lisa M., Finger Adam G., Ray, David A., Platt, Steven G., Smith, Philip N., Densmore, Llewellyn D., Anderson Todd A., McMurry Scott T. 2008. Plasma vitellogenin in Morelet's crocodiles from contaminated habitats in northern Belize. Environmental Pollution. 153:101-109.
-Smith, Philip N., Cobb, George P., Godard-Codding, Céline, Hoff, Dale, McMurry, Scott T., Rainwater, Thomas R., Reynolds, Kevin D. 2007. Contaminant exposure in terrestrial vertebrates. Environmental Pollution. 150:41-64.

Appendix C:
PROGRAM ASSESSMENT PLAN

Degree Title: Master of Science in **Arid Land Studies**

Purpose of degree program: This degree is designed for students with broad interests in several fields or for those whose career goals do not match fully with a singly identifiable academic unit or department. Emphasis is placed on continued intellectual and cultural development in a constantly changing society in which new career interests may extend over several traditional specializations.

Item	**EXPECTED LEARNING OUTCOMES**	**METHODS OF ASSESSMENT**
1)	Students will be able to demonstrate their advanced knowledge in three or more different fields of study.	In their capstone experiences (theses, examinations, or portfolios), students will have their advanced knowledge of fields judged by their faculty committees (grounded in the Rubric for Outcomes Assessment of Student Learning).
2)	Students will be able to integrate three or more fields of study.	In their capstone experiences (theses, examinations, or portfolios), students will have their integration of fields judged by their three-person faculty committees, its basis being in the Rubric for Outcomes Assessment of Student Learning.
3)	Students will demonstrate mastery of written communication.	In their capstone experiences (theses, examinations, or portfolios), students will have their mastery of written communication assessed by their faculty committees (grounded in the Rubric for Outcomes Assessment of Student Learning).
4)	Students will demonstrate effective oral communication.	In their capstone experiences (theses, examinations, or portfolios), students will have their mastery of oral communication assessed by their faculty committees (grounded in the Rubric for Outcomes Assessment of Student Learning).
5)	Students will demonstrate the ability to think critically on issues related to their chosen fields of study.	Students' critical thinking as reflected in their capstone experiences (theses, examinations, portfolios) will be assessed and reported by their committee members (grounded in the Rubric for Outcomes Assessment of Student Learning).

Appendix C:
Rubric for Outcomes Assessment of Student Learning

For each student, complete the following assessment instrument and return this form to the Graduate School.
This Assessment is based on one of the following activities (check one):
( ) Thesis
( ) Comprehensive Examination
( ) Portfolio

1) Knowledge of Fields

Indicate Field(s) of Study:

The student demonstrated knowledge of the above field(s) [CHECK ONE]

1. Not at all
2. Marginally
3. Acceptably
4. Very well
5. Excellently

2) Integration of Fields

(i.e., has the student been able to explain how the various fields or courses that she/he has taken are somehow related or share common qualities)

The student demonstrated the integration of fields of studies

1. Not at all
2. Marginally
3. Acceptably
4. Very well
5. Excellently

3) Writing Ability

The student demonstrated writing ability

1. Not at all
2. Marginally
3. Acceptably
4. Very well
5. Excellently

4) Oral Communication

The student demonstrated effective oral communication

1. Not at all
2. Marginally
3. Acceptably
4. Very well
5. Excellently

5) Critical Thinking

The student demonstrated effective critical thinking:

1. Not at all
2. Marginally
3. Acceptably
4. Very well
5. Excellently

_____
Faculty Member's Signature

Appendix D:

BUDGET – ANTICIPATED SOURCES OF FUNDING

Note: Use this chart to indicate dollar amounts anticipated from various sources. Use the reverse side of this form to specify as completely as possible each non-formula funding source.

Funding Category	1st Year	2nd Year	3rd Year	4th Year	5th Year	TOTALS
I. Formula Income*[1]			$7,559	$7,559	$3,779	$18,897
II. Other State Funding*	0	0	0	0	0	0
III. Reallocation of Existing Resources*	0	0	0	0	0	0
IV. Federal Funding* (in-hand only)	$108,000	$104,000	$104,000	$104,000	0	$420,000
V. Other Funding*	0	0	0	0	0	0
TOTALS	$108,000	$104,000	$111,559	$111,559	$3,779	438,897

[1] The Master's Degree in Arid Land Studies Program does not offer any courses at the Graduate School; therefore there is no provision to benefit from Formula Funding. All students will be enrolled in courses regularly offered by different Departments; therefore the estimate amount from formula funding will be distributed to those Departments. Most of the courses taken by MSALS students are likely to be in Science, Agriculture, and Engineering (i.e. Formula Codes 02, 05 and 06 and respective Formulas for Masters: 8.09, 7.07 and 7.63), The average formula weight for Masters students taking courses in these three areas in these areas is $472.43 (TTU Formula Funding Codes and Rates, FY 2010-2011, Weight = $62.19). In terms of Responsibility Center Management, this estimation of formula funding means increased earnings to Departments offering courses to MLAS students in addition to their disciplinary student population. In financial terms, the formula from the program is "found money" (free earnings to support increase and expansion). This estimation indicates the future growing benefit that the program delivers as it matures.

Appendix D:
BUDGET – COST TO THE INSTITUTION OF THE PROGRAM/ADMINISTRATION CHANGE

There will be ***no cost to the institution*** to implement this program. Funding to create the program will come from a grant from the US Department of Education.

Cost Category	Cost Sub-Category	Before Approval Year*	1st Year	2nd Year	3rd Year	4th Year	5th Year	TOTALS
Faculty Salaries	(New)	0	0	0	0	0	0	0
	(Reallocated)	0	0	0	0	0	0	0
Program Administration	(New)	0	0	0	0	0	0	0
	(Reassignments)	0	0	0	0	0	0	0
Graduate Assistants	(New)	0	0	0	0	0	0	0
	(Reallocated)	0	0	0	0	0	0	0
Clerical/Staff	(New)	0	0	0	0	0	0	0
	(Reallocated)	0	0	0	0	0	0	0
Supplies and Materials		0	0	0	0	0	0	0
Library & IT Resources**		0	0	0	0	0	0	0
Equipment		0	0	0	0	0	0	0
Facilities		0	0	0	0	0	0	0
Other (Identify)		0						
TOTALS		0	0	0	0	0	0	0

* Include cost incurred for three years before the proposal is approved by the Board (e.g., new faculty, library resources, equipment, facilities remodeling, etc.).

** IT = Instructional Technology

Appendix D:
BUDGET – NON-FORMULA SOURCES OF FUNDING

Note: Use this form to specify as completely as possible each of the non-formula funding sources for the dollar amounts listed on the reverse side of this form.

Funding Category	Non-Formula Funding Sources
II. Other State Funding*	#1 N/A
	#2
III. Reallocation of	#1 N/A
Existing Resources*	
	#2
IV. Federal Funding*	#1 2009 US Department of Education FIPSE EU-US Atlantis Grant
	#2
V. Other Funding*	#1 N/A
	#2

Appendix E:
FEDERAL BUDGET NARRATIVE

Salaries and Wages

Dr. Aderbal C. Correa at TTU will be the Principal Investigator/Director for this project. He will provide leadership at Texas Tech University (TTU) for a consortium including besides TTU, Sheffield University (SU), UK and the Humboldt Universität zu Berlin (HU), Germany, and will manage all phases of the project. Dr. Correa requests from the FIPSE Atlantis Program less than one month salary (Y1: $4,676; Y2: $4,731; Y3: $4,503; Y4: 4,679; total salary: $18,589) and fringe benefits at the18% rate plus health insurance (Y1: $1,357; Y2: $1,409; Y3: $1,377; Y4: $1,471; total benefits: $5,614) in salary support amounting to yearly amounts: $6,033; $6,140; $6,880; and $6,150 from years 1 through 4 respectively. The total amount requested as salary for the four-year project is $24,203.

Travel

Travel will be required every year for the Program Director to attend the annual meeting with the funding agencies (U.S. Department of Education, FIPSE and the European Union, EU). The Project Directors meeting will be held in the U.S. in 2009 and 2011 and in Europe in 2010 and 2012. Other travel will be required to visit partner universities in the UK and Germany, field stations near Junction, Texas and Albuquerque, New Mexico and possibly conferences scheduled in the U.S. and EU for the benefit of the consortium partners.

Year 1. Support is requested for:

- Travel by the TTU Project Director to the EU-US Atlantis Program annual meeting in Boston and research units in Junction, Texas and Albuquerque, New Mexico the US. Domestic travel is estimated at $1,850. International travel to meet with European partners in the UK or Germany estimated at $1,650 ($650 round trip air travel; $250 per diem for 4 days).
- An annual meeting fee of $4,000 has been allotted for purposes designated by FIPSE for budget year one.

Total travel expenditures during year 1 will be $7,500.

Year 2. Support is requested for:

- Travel by the TTU Project Director to the Atlantis annual meeting in Europe including visit to thesis field research areas in the UK and Germany estimated at $3,500 ($1,000 round trip air travel and $250 per diem for 10 days).
- Travel by the TTU Project Director to visit research stations in Texas and/or New Mexico in the US estimated at $400.

Total travel expenditures during year 2 will be $3,900.

Year 3. Support is requested for:

- Travel by the TTU Project Director to the EU-US Atlantis Program annual meeting in the US estimated at $1,500 ($900 airfare; $150 per diem for 6 days) and to visit US research areas in Junction, Texas and Albuquerque, New Mexico estimated at $800 ($400 transportation and $80 per diem during 5 days).
- International travel to meet with European partners in the UK or Germany estimated to be $1,600 ($600 round trip air travel; $250 per diem for 4 days).

Total travel expenditures during year 3 will be $3,900.

Year 4. Support is requested for:

- Travel by the TTU Project Director to the Atlantis annual meeting in Europe including visit to thesis field research areas in the UK and Germany estimated at $3,500 ($1,000 round trip air travel and $250 per diem for 10 days).
- Travel by the TTU Project Director to visit research stations in Texas and/or New Mexico in the US estimated at $400.

Total travel expenditures during the fourth year will be $3,900.
The total travel amount requested during the 4-year project is $15,200.

Materials and Supplies

The program will require communication using conventional and electronic mail, telephone, courier service and fax during the four years of the project. In addition, there will be expenditures with reproduction of documents and education materials, paper, ink, printer supplies, transparencies, zip discs, CD ROMs, CD-RWs, printer, camera, and other office supplies. The amount requested for materials and supplies for

years 1 though 4 is $250, $80, $300, and $30 respectively. The total amount request for the project is $660.

Contractual Commitments

A consultant outside TTU will be contracted to evaluate yearly the project. Dr. James McCartney, Professor *Emeritus* of Sociology at the University of Missouri-Columbia and the former Director of the International Center and Interim Associate Vice-Provost for International Programs will serve as an external consultant during the life of the project. Dr. McCartney will be paid $3,000 per year to provide this service to the project. The total amount requested for project evaluation amounts to $12,000 for the life of the project.

Other

The amount of $1,500 per year will be available in the budget to cover expenses with the assessment of the proficiency of outgoing students in the German language. The total amount allowed for these expenses is $6,000 for the duration of the project.

The amounts of $50 for years 1, 3 and 4 and $10 for year 2 are included in the budget to cover miscellaneous expenses including expenses holding student recruiting meetings. The total amount of $160 is request for miscellaneous expense during the entire project.

Student Stipends

The project estimates that every year, starting on Year 1, TTU will send 6 students per year for a total of 24 students during the life of the project. Each student will receive a mobility stipend of $12,000 per year to cover expenses that would not be paid attending school at the home university including round trip airfare, passport, visa, vaccination, airport transfers, land transportation between Sheffield, UK and Berlin, Germany, German language training and/or tutoring if needed and miscellaneous living expenses.

Student stipends budgeted for years 1 through 4 for 6 students per year are:

Year 1: Mobility stipends: $72,000
Year 2: Mobility stipends: $72,000
Year 3: Mobility stipends: $72,000
Year 4: Mobility stipends: $72,000

The total amount requested for student stipends during the life of the project is $288,000.

Faculty Stipends

Travel to EU by TTU faculty members is one of the approaches to establish and strengthen cooperation among project participants and to promote project sustainability beyond the initial funding period. Participation in international thesis committees will be another major incentive to nurture personal connections established during this program. The project will provide to TTU faculty collaborating with the project every year travel stipends of $1,000 per week plus a fixed amount of $1,000 for travel per scholar in relation to scholarly work including teaching at a European partner institution with a minimum of one week and a maximum of eight weeks. The project estimates that every year five faculty members will take advantage of this opportunity traveling to SU or HU for two weeks, but this number is flexible. Estimate amounts assigned to faculty travel stipends are:

Year 1: Mobility stipends: $15,000
Year 2: Mobility stipends: $15,000
Year 3: Mobility stipends: $15,000
Year 4: Mobility stipends: $15,000

The total amount requested for faculty travel stipends during the life of the project is $60,000.

Project Administrative Costs

TTU will charge 8% of direct costs to administer this project. The amounts charged as administrative costs for years 1 through 4 are: $2,667, $2,370, $2,370 and $2,370 respectively. Total amount requested from the agency for the life of the project is $9,778.

TTU will contribute to the project with 38.5% of the unrecovered overhead.

Total Project Costs

The total amounts requested from FIPSE for this project for years 1 through 4 will be: $108,000; $104,000; $104,000; and $104,000. The total amount of $420,000 is request for total project expenses during the entire life of the project.

Appendix F:
FACULTY ROSTER FORMS
Qualifications of Full-Time and Part-Time Faculty

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Interdisciplinary Studies, Arid Land Studies, Graduate School

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught** ***Bold course*** *indicates inclusion in Arid Land Studies curriculum, described in Appendix.*	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Ernest B. Fish (F)	**-NRM 5317 Watershed Management (G)** **-NRM 5404 Aerial Terrain Analysis (G)** **-NRM 6303 Imagery Interpretation for Natural Resource Management (G)** **-NRM 6305 Geospatial Technologies in Natural Resource Management (G)**	-B.S. Forest-Range Management, Colorado State University, 1964. -M.S. Range Ecology/Statistics, Colorado State University, 1966. -Ph.D. Watershed Management Statistics, University of Arizona, 1973.	
2. Dr. Vivian Allen (F)	**-AGSC 5303 Ecology of Grazing Lands Systems (G)**	-Ph.D. Louisiana State University. 1979. Agronomy. Minor: Animal Science. -M. S. Louisiana State University. 1973. Agronomy. Minor: Animal Science. -B.S. University of Tennessee, Martin. 1962. General Agriculture.	

3. Dr. Stephen Maas (F)	**-PSS 5329 Precision Agriculture (G)**	-Ph.D. Texas A&M University. 1985. Agronomy. -M.S. Texas A&M University. 1975. Meteorology. -B.S. Texas A&M University. 1973. Meteorology. -Temple Junior College. Temple, TX. 1969-70.	
4. Dr. Robert Lascano (P)	**-PSS 5333 Soil and Plant Relationships (G)**	-Ph.D. Texas A&M University. 1982. -M.S. Texas A&M University. 1977. -B.S. Texas A&M University. 1974.	
5. Dr. Kevin Bronson (F)	**-PSS 5334 Soils and Crops in Arid Lands (G)**	-Ph.D. Auburn University. 1989. Major: Soil Fertility. -M.S. University of the Philippines at Los Banos. 1984. Major: Soil Fertility. Minor: Agricultural Economics. -B.S. University of Maryland. 1981. Major: Soil Science.	
6. Dr. Robert D. Cox (F)	**-NRM 5310 Advanced Range Ecology (G)**	-Sep 2006 Ph.D., Botany. (Ecology and Conservation Biology) University of California-Riverside. -Aug 2000 MS., Botany. Brigham Young University. -Dec 1997 BS., Conservation Biology (Emphasis in Zoology). Brigham Young University.	

7. Dr. Clint Boal (F)	**-NRM 5322 Advance nongame Ecology and Management (G)**	-Ph.D. 1997. Wildlife Ecology. University of Arizona. -M.S. 1993. Wildlife Ecology. University of Arizona. -B.S. 1990. Renewable Natural Resources, University of Arizona.	
8. Dr. Jeff Lee (F)	**-GEOG 5306 Seminar in Geography of Arid Lands (G)**	-Ph.D., Geography, Arizona State University, 1990. -M.A., Geography, University of California, Los Angeles, 1984. -B.A., Geography, University of California, Los Angeles, 1979.	
9. Dr. Kevin Mulligan (F)	**-GEOG 5300 Geographic Information Systems (G)** **-GEOG 5302 Advanced Geographic Information Systems (G)**	-Ph.D., Geography, Texas A&M University, 1997. -M.A., Geography, University of California, Los Angeles, 1985. -B.A., Geography, University of California, Los Angeles, 1979.	
10. Dr. Tina Delahunty (F)	**-GEOG 5301 Remote Sensing of the Environment (G)**	-Ph.D., Geography, University of Florida, 2002. -M.A., Geography, Florida Atlantic University, 1998. -B.S., Natural Resource Planning, Humboldt State University, 1995.	
11. Dr. Perry Carter (F)	**-GEOG 5309 Seminar in Regional Analysis (G)**	-Ph.D., Geography, Ohio State University, 1998. -M.A., Political Economy, University of Texas at Dallas, 1992. -M.A., Geography, University of Georgia, 1986. -A.B., Geography, University of Georgia, 1983.	

12. Dr. Nancy E. McIntyre (F)	**-BIOL 5330 Advanced Landscape Ecology (G)**	-Ph.D. Ecology, Colorado State University, 1998 -M.S. Zoology, University of Georgia, 1993 -B.S. Zoology, University of Georgia, 1991	
13. Dr. David Leverington (F)	**-GEOL 5341 Digital Imagery in Geosciences (G)**	-1996-2001 Ph.D., Geological Sciences, University of Manitoba, Winnipeg. -1993-1995 M.Sc., Earth Science, Ottawa-Carleton Geoscience Centre, University of Ottawa. -1988-1992 B.A. (Hon.), Physical Geography, University of Ottawa.	
14. Dr. Seiichi Nagihara (F)	**-GEOL 5342 Spatial Data Analysis and Modeling in Geosciences (G)**	-Ph.D. (Geological Sciences), University of Texas at Austin, 1992. -M.S. (Geophysics), Chiba University, Japan, 1987. -B.S. (Geophysics), Chiba University, Japan, 1985.	
15. Dr. Colleen Ann Leary (F)	**-ATMO 5302 Weather, Climate, and Applications (G)**	-B.S. Massachusetts Institute of Technology, 1970. -M.S. Massachusetts Institute of Technology, 1973. -Ph.D. University of Washington, 1978.	
16. Dr. Ken Rainwater (F)	**-CE 5366 Water Resources Management (G)** **-CE 5363 Groundwater Hydrology (G)** **-CE 5364 Groundwater Transport Phenomena (G)**	-B.S. Civil Engineering, Rice University, 1979. -M.S. Civil Engineering, (water resources), The University of Texas at Austin, 1982. -Ph.D. (water resources), The University of Texas at Austin, 1985.	

17. Dr. Ted Cleveland (F)	**-CE 5361 Surface Water Hydrology (G)**	-Ph.D. University of California, Los Angeles, 1989, Civil Engineering. -M.S. University of California, Los Angeles, 1987, Civil Engineering. -B.S. Humboldt State University, 1986, Environmental Resources Engineering.	
18. Dr. Clifford B. Fedler (F)	**-CE 5394 Natural Systems for Wastewater Treatment (G)**	-B.S. Agricultural Engineering, Iowa State University, 1979. -M.S. Agricultural Engineering, Iowa State University, 1981. -M.S. Civil Engineering, Iowa State University, 1981. -Ph.D. Agricultural Engineering, University of Illinois, 1985.	
19. Dr. Phil Smith (F)	**-ENTX 6361 Environmental and Wildlife Toxicology** **-ENTX 6371 Procedure and Techniques in Ecological Risk Assessment (G)**	-Ph.D. Environmental Toxicology, Texas Tech University 2000. -M.S. Clemson University's Institute of Wildlife and Environmental Toxicology 1997. -B.S. Chemistry & Biology, Murray State University 1989.	
20. Dr. Jeff Johnson (F)	**-AAEC 5314 Environmental Economics and Policy Analysis (G)**	-2003 Ph.D. Agricultural Economics, Texas Tech University. -2002 Master of Strategic Studies, U.S. Army War College. -1981 Master of Agriculture Agricultural Economics, Texas A&M University. -1975 Bachelor of Science Animal Science, Texas A&M University.	

For an electronic version of this form and its instructions for completion, access http://www.sacscoc.org*, click onto Resources, click onto Institutional, and *click onto Faculty Roster Form and Faculty Roster Instructions. Please read the instructions before completing the form.

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Agriculture and Applied Economics, College of Agricultural Sciences and Natural Resources

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Jeff Johnson (F)	**-AAEC 5314 Environmental Economics and Policy Analysis (G)**	-2003 Ph.D. Agricultural Economics, Texas Tech University. -2002 Master of Strategic Studies, U.S. Army War College. -1981 Master of Agriculture Agricultural Economics, Texas A&M University. -1975 Bachelor of Science Animal Science, Texas A&M University.	

For an electronic version of this form and its instructions for completion, access http://www.sacscoc.org*, click onto Resources, click onto Institutional, and *click onto Faculty Roster Form and Faculty Roster Instructions. Please read the instructions before completing the form.

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Agricultural Science, College of Agricultural Sciences and Natural Resources

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Vivian Allen (F)	**-AGSC 5303 Ecology of Grazing Lands Systems (G)**	-Ph.D. Louisiana State University. 1979. Agronomy. Minor: Animal Science. -M. S. Louisiana State University. 1973. Agronomy. Minor: Animal Science. -B.S. University of Tennessee, Martin. 1962. General Agriculture.	

For an electronic version of this form and its instructions for completion, access http://www.sacscoc.org*, click onto Resources, click onto Institutional, and *click onto Faculty Roster Form and Faculty Roster Instructions. Please read the instructions before completing the form.

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Atmospheric Sciences, Department of Geosciences

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Colleen Ann Leary (F)	**-ATMO 5302 Weather, Climate, and Applications (G)**	-B.S. Massachusetts Institute of Technology, 1970. -M.S. Massachusetts Institute of Technology, 1973. -Ph.D. University of Washington, 1978.	

For an electronic version of this form and its instructions for completion, access http://www.sacscoc.org*, click onto Resources, click onto Institutional, and *click onto Faculty Roster Form and Faculty Roster Instructions. Please read the instructions before completing the form.

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Ecology/Biology, Department of Biological Sciences

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Nancy E. McIntyre (F)	**-BIOL 5330 Advanced Landscape Ecology (G)**	-Ph.D. Ecology, Colorado State University, 1998 -M.S. Zoology, University of Georgia, 1993 -B.S. Zoology, University of Georgia, 1991	

For an electronic version of this form and its instructions for completion, access http://www.sacscoc.org*, click onto Resources, click onto Institutional, and *click onto Faculty Roster Form and Faculty Roster Instructions. Please read the instructions before completing the form.

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Civil Engineering, Department of Civil and Environmental Engineering

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Ken Rainwater (F)	**-CE 5366 Water Resources Management (G)** **-CE 5363 Groundwater Hydrology (G)** **-CE 5364 Groundwater Transport Phenomena (G)**	-B.S. Civil Engineering, Rice University, 1979. -M.S. Civil Engineering, (water resources), The University of Texas at Austin, 1982. -Ph.D. (water resources), The University of Texas at Austin, 1985.	
2. Dr. Ted Cleveland (F)	**-CE 5361 Surface Water Hydrology (G)**	-Ph.D. University of California, Los Angeles, 1989, Civil Engineering. -M.S. University of California, Los Angeles, 1987, Civil Engineering. -B.S. Humboldt State University, 1986, Environmental Resources Engineering.	
3. Dr. Clifford B. Fedler (F)	**-CE 5394 Natural Systems for Wastewater Treatment (G)**	-B.S. Agricultural Engineering, Iowa State University, 1979. -M.S. Agricultural Engineering, Iowa State University, 1981. -M.S. Civil Engineering, Iowa State University, 1981. -Ph.D. Agricultural Engineering, University of Illinois, 1985.	

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Department of Environmental Toxicology

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Phil Smith (F)	**-ENTX 6361 Environmental and Wildlife Toxicology** **-ENTX 6371 Procedure and Techniques in Ecological Risk Assessment (G)**	-Ph.D. Environmental Toxicology, Texas Tech University 2000. -M.S. Clemson University's Institute of Wildlife and Environmental Toxicology 1997. -B.S. Chemistry & Biology, Murray State University 1989.	

For an electronic version of this form and its instructions for completion, access http://www.sacscoc.org*, click onto Resources, click onto Institutional, and *click onto Faculty Roster Form and Faculty Roster Instructions. Please read the instructions before completing the form.

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Geography, Department of Economics and Geography

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Jeff Lee (F)	**-GEOG 5306 Seminar in Geography of Arid Lands (G)**	-Ph.D., Geography, Arizona State University, 1990. -M.A., Geography, University of California, Los Angeles, 1984. -B.A., Geography, University of California, Los Angeles, 1979.	
2. Dr. Kevin Mulligan (F)	**-GEOG 5300 Geographic Information Systems (G)** **-GEOG 5302 Advanced Geographic Information Systems (G)**	-Ph.D., Geography, Texas A&M University, 1997. -M.A., Geography, University of California, Los Angeles, 1985. -B.A., Geography, University of California, Los Angeles, 1979.	
3. Dr. Tina Delahunty (F)	**-GEOG 5301 Remote Sensing of the Environment (G)**	-Ph.D., Geography, University of Florida, 2002. -M.A., Geography, Florida Atlantic University, 1998. -B.S., Natural Resource Planning, Humboldt State University, 1995.	
4. Dr. Perry Carter (F)	**-GEOG 5309 Seminar in Regional Analysis (G)**	-Ph.D., Geography, Ohio State University, 1998. -M.A., Political Economy, University of Texas at Dallas, 1992. -M.A., Geography, University of Georgia, 1986. -A.B., Geography, University of Georgia, 1983.	

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Geology, Department of Geosciences

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. David Leverington (F)	**-GEOL 5341 Digital Imagery in Geosciences (G)**	-1996-2001 Ph.D., Geological Sciences, University of Manitoba, Winnipeg. -1993-1995 M.Sc., Earth Science, Ottawa-Carleton Geoscience Centre, University of Ottawa. -1988-1992 B.A. (Hon.), Physical Geography, University of Ottawa.	
2. Dr. Seiichi Nagihara (F)	**-GEOL 5342 Spatial Data Analysis and Modeling in Geosciences (G)**	-Ph.D. (Geological Sciences), University of Texas at Austin, 1992. -M.S. (Geophysics), Chiba University, Japan, 1987. -B.S. (Geophysics), Chiba University, Japan, 1985.	

For an electronic version of this form and its instructions for completion, access http://www.sacscoc.org*, click onto Resources, click onto Institutional, and *click onto Faculty Roster Form and Faculty Roster Instructions. Please read the instructions before completing the form.

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Natural Resource Management, College of Agricultural Sciences and Natural Resources

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Ernest B. Fish (F)	**-NRM 5317 Watershed Management (G)** **-NRM 5404 Aerial Terrain Analysis (G)** **-NRM 6303 Imagery Interpretation for Natural Resource Management (G)** **-NRM 6305 Geospatial Technologies in Natural Resource Management (G)**	-B.S. Forest-Range Management, Colorado State University, 1964. -M.S. Range Ecology/Statistics, Colorado State University, 1966. -Ph.D. Watershed Management Statistics, University of Arizona, 1973.	
2. Dr. Robert D. Cox (F)	**-NRM 5310 Advanced Range Ecology (G)**	-Sep 2006 Ph.D., Botany. (Ecology and Conservation Biology) University of California-Riverside. -Aug 2000 MS., Botany. Brigham Young University. -Dec 1997 BS., Conservation Biology (Emphasis in Zoology). Brigham Young University.	
3. Dr. Clint Boal (F)	**-NRM 5322 Advance nongame Ecology and Management (G)**	-Ph.D. 1997. Wildlife Ecology. University of Arizona. -M.S. 1993. Wildlife Ecology. University of Arizona. -B.S. 1990. Renewable Natural Resources, University of Arizona.	

Name of Institution: Texas Tech University

Name of Academic Area, Discipline, Department/School: Plant and Soil Science, College of Agricultural Sciences and Natural Resources

Academic Term(s) Included: Spring, Summer, and Fall **Date Form Completed:** February 16, 2010

1	2	3	4
Name	**Courses Taught**	**Relevant Academic Degrees and Course Credits Earned**	**Other Qualifications**
1. Dr. Stephen Maas (F)	**-PSS 5329 Precision Agriculture (G)**	-Ph.D. Texas A&M University. 1985. Agronomy. -M.S. Texas A&M University. 1975. Meteorology. -B.S. Texas A&M University. 1973. Meteorology. -Temple Junior College. Temple, TX. 1969-70.	
2. Dr. Robert Lascano (P)	**-PSS 5333 Soil and Plant Relationships (G)**	-Ph.D. Texas A&M University. 1982. -M.S. Texas A&M University. 1977. -B.S. Texas A&M University. 1974.	
3. Dr. Kevin Bronson (F)	**-PSS 5334 Soils and Crops in Arid Lands (G)**	-Ph.D. Auburn University. 1989. Major: Soil Fertility. -M.S. University of the Philippines at Los Banos. 1984. Major: Soil Fertility. Minor: Agricultural Economics. -B.S. University of Maryland. 1981. Major: Soil Science.	