### I. ASCRC General Education Form

<table>
<thead>
<tr>
<th>Group</th>
<th>Natural Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dept/Program</td>
<td>EVST</td>
</tr>
<tr>
<td>Course Title</td>
<td>Environmental Science</td>
</tr>
<tr>
<td>Prerequisite</td>
<td>None</td>
</tr>
<tr>
<td>Credits</td>
<td>3</td>
</tr>
</tbody>
</table>

### II. Endorsement/Approvals

Complete the form and obtain signatures before submitting to Faculty Senate Office.

<table>
<thead>
<tr>
<th>Please type / print name</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor</td>
<td>Vicki Watson</td>
<td></td>
</tr>
<tr>
<td>Phone / Email</td>
<td>X5153 <a href="mailto:vicki.watson@umontana.edu">vicki.watson@umontana.edu</a></td>
<td></td>
</tr>
<tr>
<td>Program Chair</td>
<td>Len Broberg</td>
<td></td>
</tr>
<tr>
<td>Dean</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### III. Description and purpose of the course:

General Education courses must be introductory and foundational. They must emphasize breadth, context, and connectedness; and relate course content to students’ future lives: See Preamble:

[http://www.umt.edu/facultysenate/gened/GEPreamble_final.htm](http://www.umt.edu/facultysenate/gened/GEPreamble_final.htm)

Class Goals: Provide students with opportunities to use scientific knowledge to make a difference in their lives and in their community;

- Help students to build: scientific and ecological literacy; critical thinking & research skills;
- an understanding of the scientific principles that underlie & inform environmental issues;
- habits of scientifically informed, active participation in social decisions,
- of sustainable living, and of service to their community and the earth.

The scientific principles learned in the course are further illustrated and related to students’ lives by discussing how these principles underpin selected environmental issues and laws and how the scientific principles inform our choices of how to meet our basic needs more sustainably.
| Courses explore a discipline in the natural sciences and demonstrate how the scientific method is used within the discipline to draw scientific conclusions. | The discipline explored is Environmental Science. The class begins with a discussion of the scientific method presented as a cycle of growing knowledge—starting from theory (the existing body of knowledge), noting gaps & conflicts and using these to generate relevant questions & hypotheses; moving on to designing critical studies that will answer questions and test hypotheses; describing how data quality & uncertainty is determined; describing how data are analyzed and interpreted to look for patterns, trends, and possible cause-effect relationships; how conclusions are drawn using the simplest possible explanation consistent with observations, and finally answering the original question or selecting the best supported hypothesis, thus filling the gap in knowledge or resolving the controversy and feeding back into theory. Steps along the cycle are illustrated with examples from Environmental Science. |
| Courses address the concept of analytic uncertainty and the rigorous process required to take an idea to a hypothesis and then to a validated scientific theory. | Key scientific approaches are discussed including description & experimentation, Induction and deduction, reductionism & holism, correlation vs causality, sources of uncertainty and the preponderance of the scientific evidence. These ideas are illustrated with examples from Environmental Science. |
| Lab courses..... | This is not a lab course, but we do take lots of field trips and perform community service that allows hands-on use of principles learned in the lecture. |
### V. Student Learning Goals: Briefly explain how this course will meet the applicable learning goals. See: [http://www.umt.edu/facultysenate/ASCRCx/Adocuments/GE_Criteria5-1-08.htm](http://www.umt.edu/facultysenate/ASCRCx/Adocuments/GE_Criteria5-1-08.htm)

<table>
<thead>
<tr>
<th>Goal</th>
<th>Course Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Understand the general principles associated with the discipline(s) studied;</td>
<td>The course covers key environmental &amp; ecological principles, using local examples. Included are: human dependence on and effects on ecosystem processes of energy flow, material cycling (especially water, nutrients and toxic substances), ecosystem services &amp; resources and their interconnections (relevance of energy budgets &amp; climate change are also discussed); community processes of species interactions, change (succession), disturbance, and the role of various kinds of diversity in providing resilience &amp; persistence of communities; population processes of evolution and adaptation, population growth, limits and carrying capacity. Each of the above is related to environmental sustainability &amp; human choices. Knowledge is tested using in-class essay exams, discussion sections, and a research paper.</td>
</tr>
<tr>
<td>2. Understand the methodology and activities scientists use to gather, validate and interpret data related to natural processes;</td>
<td>See discussion of the Science Cycle under the first course criteria. In addition, some of the principles discussed are explained in terms of the methods used to gather, validate &amp; interpret data relevant to those principles. Knowledge is tested using in-class essay exams, discussion sections, and a research paper.</td>
</tr>
<tr>
<td>3. Detect patterns, draw conclusions, develop conjectures and hypotheses, and test them by appropriate means and experiments;</td>
<td>See discussion of the Science Cycle under the first course criteria. In addition, some of the principles discussed are used to illustrate how data can be organized to detect patterns, draw conclusions, and suggest hypotheses that can be tested in appropriate studies. For example, which factor is most limiting population growth. Knowledge is tested using in-class essay exams, discussion sections, and a research paper.</td>
</tr>
</tbody>
</table>
4. understand how scientific laws and theories are verified by quantitative measurement, scientific observation, and logical/critical reasoning; and

5. understand the means by which analytic uncertainty is quantified and expressed in the natural sciences.

See discussion of the Science Cycle under the first course criteria. In addition, a few key physical laws (conservation of mass & energy) that are central to environmental science are contrasted with key ecological principles which while also central to environmental science, do not reach the level of certainty of the physical laws. The nature of evidence used in studying complex systems is discussed.

Sources of uncertainty are briefly discussed in a general way in connection with the Science cycle (explanations of sources of error, accuracy & precision). But sources of uncertainty are discussed in some detail in connection with measuring and predicting environmental fate of certain toxic substances. In addition, several areas of scientific controversy and areas of scientific consensus are discussed, along with the reasons why scientists may legitimately disagree with one another. Students are instructed in how to identify areas of controversy & consensus and how to identify which viewpoint is supported by the majority of authorities in the field.

VII. Syllabus: Paste syllabus below or attach and send digital copy with form. The syllabus should clearly describe how the above criteria are satisfied. For assistance on syllabus preparation see: http://teaching.berkeley.edu/bgd/syllabus.html

The syllabus of EVST 101 is attached.

*Please note: As an instructor of a general education course, you will be expected to provide sample assessment items and corresponding responses to the Assessment Advisory Committee.

EVST 101 ENVIRONMENTAL SCIENCE FALL 2008 Syllabus p. 1

DR. VICKI WATSON, 243-5153, email Vicki.watson@umontana.edu
OFFICE: 101 Natural Science, office hrs: 10-12 Wed (usually) & by appointment

Class Goals: Provide students with opportunities to use scientific knowledge to make a difference; Help students build: scientific & ecological literacy; skills in critical thinking, research & self-instruction; an understanding of the scientific basis of environmental issues, policies, laws; and habits of informed, active participation in social decisions, of sustainable living, and of service to their community and the earth.
<table>
<thead>
<tr>
<th>Date</th>
<th>LECTURE TOPICS at a glance</th>
<th>References (identified at page bottom*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-Aug</td>
<td>Course goals &amp; mechanics; What is Environmental Science?</td>
<td>FP p1-20, Mch1, <a href="http://www.earthcharter.org">www.earthcharter.org</a></td>
</tr>
<tr>
<td>28-Aug</td>
<td><strong>Literacy—Scientific &amp; Ecological; Science Cycle &amp; approaches</strong></td>
<td>M ch2, FP-13-14 (sci or philosophy?)</td>
</tr>
<tr>
<td>2-Sep</td>
<td>Ecosystems—energy flow, matter cycles, watersheds</td>
<td>M on flooding; AO part I (ch4 recommend)</td>
</tr>
<tr>
<td>4-Sep</td>
<td>env. fate (can’t throw it away ), biomagnification</td>
<td>FP-21-22 water cycle</td>
</tr>
<tr>
<td>9-Sep</td>
<td>ecological services, climate change</td>
<td>check out the web sites on FP 23</td>
</tr>
<tr>
<td>11-Sep</td>
<td>Communities—connections—you can’t do just one thing</td>
<td>M on communities, species interactions</td>
</tr>
<tr>
<td>16-Sep</td>
<td>all creatures have a role; kinds of biodiversity</td>
<td>see world community types (ecoregions)</td>
</tr>
<tr>
<td>18-Sep</td>
<td>Populations— evolution/adaptation, flexibility</td>
<td><a href="http://www.worldwildlife.org/wildworld">www.worldwildlife.org/wildworld</a></td>
</tr>
<tr>
<td>23-Sep</td>
<td>population growth, limits, carrying capacity (K)</td>
<td>Miller on populations &amp; species</td>
</tr>
<tr>
<td>25-Sep</td>
<td>Ecofootprint – with Susan Anderson, sustainablebusinesscouncil.org</td>
<td>Hardin on Cultural K in FP18</td>
</tr>
<tr>
<td>30-Sep</td>
<td><em><strong><strong>EXAM 1</strong></strong></em> grades posted by Oct 3; <strong>last day to drop/change grade system ‘easily’ Oct 6</strong></td>
<td>FP 25.1-6; <a href="http://www.myfootprint.org">www.myfootprint.org</a></td>
</tr>
<tr>
<td>2-Oct</td>
<td>Scientific Basis of Env Laws &amp; Policies</td>
<td>M on env politics/law; FP 26a&amp;b (NEP,</td>
</tr>
<tr>
<td>2-Oct</td>
<td>Scientists’ role in env policy, NEPA, Tragedy of Commons</td>
<td>FP 18; full article: at dieoff.org/page95.h</td>
</tr>
<tr>
<td>7-Oct</td>
<td>LAND (MUSY, NFMA, Fire), quantifying sustainable use</td>
<td>M on biodiv/ecosystems + fire ecology</td>
</tr>
<tr>
<td>9-Oct</td>
<td>WATER (Clean Water Act, etc) &amp; Watershed CPR</td>
<td>M on water + FP 27 (CWA) + AO ch 10</td>
</tr>
<tr>
<td>14-Oct</td>
<td>AIR (Clean Air Act)—Garon Smith, UM Chemistry, air science in MT</td>
<td>M on air</td>
</tr>
<tr>
<td>16-Oct</td>
<td>LIFE/Biodiversity (ESA, etc), population viability</td>
<td>M on biodiversity/species approach</td>
</tr>
<tr>
<td>21-Oct</td>
<td>TOXICS (TSCA, FIFRA, etc), env fate uncertainty</td>
<td>M on risk &amp; toxicology, FP p 28-29</td>
</tr>
<tr>
<td>23-Oct</td>
<td>WASTE/life cycle analysis (RCRA, etc) - UM Recycling Edi Stan</td>
<td>M on waste; <a href="http://www.facs.umt.edu/recycle">www.facs.umt.edu/recycle</a></td>
</tr>
<tr>
<td>2-Oct</td>
<td>Using Science to Meet Our Needs Sustainably</td>
<td>Nov 4-- VOTE! ; Nov 11-Vet's day</td>
</tr>
<tr>
<td>28-Oct</td>
<td>Energy — Pat Judge, <a href="http://www.meic.org">www.meic.org</a></td>
<td>M on energy</td>
</tr>
<tr>
<td>30-Oct</td>
<td>Food — Josh Slotnick, PEAS, <a href="http://www.gardencityharvest.org">www.gardencityharvest.org</a></td>
<td>M ch on soil/food; <a href="http://www.agroecology.org">www.agroecology.org</a> use M index to find transportation</td>
</tr>
<tr>
<td>6-Nov</td>
<td>Shelter — Steve Loken Builders</td>
<td>M on groundwater</td>
</tr>
<tr>
<td>13-Nov</td>
<td>Transportation — Bob Giordano, MIST &amp; Nancy Wilson ASUM trans</td>
<td>M on groundwater</td>
</tr>
<tr>
<td>18-Nov</td>
<td>Water — Michelle Frodey-Hutchins, Miss Water Quality District</td>
<td><a href="http://www.co.missoula.mt.us/wq/">www.co.missoula.mt.us/wq/</a></td>
</tr>
<tr>
<td>20-Nov</td>
<td>*** **EXAM 2 *****</td>
<td>Nov 27 Thanksgiving (Think Globally, Eat Loc</td>
</tr>
<tr>
<td>25-Nov</td>
<td>films &amp; food</td>
<td>ER—Eco Literacy &amp; MT Constitution by</td>
</tr>
<tr>
<td>2-Dec</td>
<td>Environmental impacts of war or student presentations</td>
<td>M’s last chapter; &amp; rest of FP &amp; ER</td>
</tr>
<tr>
<td>4-Dec</td>
<td>Living Sustainably &amp; Equitably, evaluations &amp; fun</td>
<td><strong>MAKEUP EXAM, comprehensive, by appointment only</strong> Monday, 3:20-5:20 pm</td>
</tr>
<tr>
<td>8-Dec</td>
<td><strong>MAKEUP EXAM, comprehensive, by appointment only</strong> Monday, 3:20-5:20 pm</td>
<td><strong>MAKEUP EXAM, comprehensive, by appointment only</strong> Monday, 3:20-5:20 pm</td>
</tr>
<tr>
<td></td>
<td><strong>References:</strong> Fp = Facpac; # = pages; AO = Alice Outwater’s Water (one chapter from part I &amp; one from part II)</td>
<td>M = Miller’s Sustaining the Earth</td>
</tr>
<tr>
<td></td>
<td>M = Miller’s Sustaining the Earth</td>
<td>or any env science text (use table of contents &amp; index)</td>
</tr>
<tr>
<td></td>
<td>ER = e-reserve at <a href="http://eres.lib.umt.edu">http://eres.lib.umt.edu</a></td>
<td>( More reading guidance in lecture)</td>
</tr>
<tr>
<td></td>
<td>*** See EVST’s online calendar <a href="http://www.umt.edu/conservationcalendar">www.umt.edu/conservationcalendar</a></td>
<td>for field trips, service options, etc</td>
</tr>
</tbody>
</table>

***See EVST’s online calendar [www.umt.edu/conservationcalendar](http://www.umt.edu/conservationcalendar) for field trips, service options, etc***
Grade based on percentage of 600 points earned

HOW TO EARN POINTS (maximum possible points 670—so extra credit is already 'built in'):

- 200 pts  2 Midterm Exams (100 each); ‘final’ is a makeup – must have excused absence to take
- 100 pts  Service Project & proposal (10) & report & thank you letter (90)
- 100 pts  Research project: proposal (10), paper (70), letter to decision maker (20), (extra credit for evidence of impact)
- 50 pts  Portfolio—demonstrate your Science Literacy
- 80 pts  Field trips & reports (due one week after the field trip)
- 50 pts  Lecture participation (based on in-class essays)
- 50 pts  Help session participation
- 30 pts  Presentation (oral, poster, or web page) on service project or research paper
- 10 pts  Learning Contract (required)

HOW TO LOSE POINTS:

- Unexcused absence from field trip once signed up – drop a letter grade for course.
- Late work – Each week an assignment is late, it loses half its value.

ASSIGNMENTS ARE DUE IN HELP SESSION during WEEK INDICATED BELOW; Keep a copy of all assignments turned in. INSTRUCTIONS FOR ALL ASSIGNMENTS ARE IN FAC PAC

WEEK OF WHAT HAPPENS IN HELP SESSION – Discuss study questions, student concerns, and the items below

- 8-26  Claim a place in a help session; Introduce yourself and your interests; go over fac pac instructions
- 9-2   Discuss study questions, field trips, and project ideas
- 9-9   Service project proposal (10pts) due; you may change your project but submit new proposal if you do.
- 9-16  Project proposals returned and discussed. Be sure your project is approved.
- 9-23  Review for exam
- 9-30  EXAM this week -- nothing due; help sessions do not meet; TA’s will be grading.
- 10-7  Learning Contract (10 pts) and Research Project proposal (10pts) due; Exam returned & discussed.
- 10-14 Research Proposal returned; Exam challenges due; Progress report on Service Project due (short).
- 10-21 Progress report due on Research project (include a detailed outline & alphabetized list of references)
- 10-28 Research paper outline returned. Day of Dialog activities www.umt.edu/dayofdialogue
- 11-4  Review for exam; early presentations; Service project final report due (must include thank you letter);
- 11-11 Review for exam; early presentations
11-18  **EXAM this week** on Nov 20 -- nothing due; review for exam continued

11-25  Help sessions do not meet this week (Thanksgiving)

12-2  ALL Remaining WORK DUE  (research papers, final reports, portfolios, presentations)  
      All your work must be picked up by end of finals week to receive credit.  
      After finals week + 1, IT WILL BE RECYCLED!
A. COMMUNITY SERVICE LEARNING PROJECT—up to 100 pts

UM wants all its graduates to develop the habit of community service and urges instructors to include community service in classes. Students can earn up to 100 pts by providing a community service (10 hr minimum) that serves to protect/restore our environment & build a more sustainable society. You may do group or individual projects. Provide your TA (help session leader) with a short proposal for your service (need/environmental benefit, group served, what you will do, time required) & get approval before proceeding. To earn points for your service project, you must submit a final report that includes your proposal, your project evaluation, and a letter of thanks from those served. Your evaluation of this experience should describe: what you did and learned; how it benefited the community and the earth by increasing sustainability; how you used skills or knowledge from this class; how the project contributed to your preparation for life &/or career; your level of satisfaction in the experience; how the project could have been improved. If you worked on a group project, you must also evaluate the contribution of each group member. Reports should be a couple of pages at least.

Some ideas for community service projects (TAs will have more, also note Volunteer Fair in UC Sept 10, 10-2)
- Help Missoula Health Dept. with its Household Hazardous Waste Collection Sept 19-20
- Help restore Missoula open space lands on Public Land Day Sept 27
- Help grow food for the food bank at the PEAS farm – all Sept
- Help UM Recycling, ASUM Transportation, or UM Sustainable Campus Committee with projects
- Help community groups (MUD, WEN, etc) with their projects (many will come to class)
- see also web pages of UM Office of Civic Engagement and EVST’s online calendar (www.umt.edu/conservationcalendar)

B. RESEARCH PAPER AND LETTER TO DECISION MAKER —up to 100 pts

UM wants its graduates to be informed, active participants in our democracy. Students can earn up to 100 pts by writing a letter & research paper on a timely environmental issue. Your 1-2 page letter to a key decision maker will be based on your research paper (about 5 pages, single spaced; double space between paragraphs). Give your TA a proposal (topic, why it is timely, who is target of letter). Your TA will provide you with feedback on your paper & letter, and you will mail the letter & paper to your target audience. If you develop a portfolio, include the proposal, paper, letter and any response you receive. Possible targets for your letter(s):
- elected representative (national, state, local)– comment on pending legislation, ordinance, plan, voting record
- executive agency decision maker (national, state, local)—comment on upcoming decision (EIS, management plan, permit, etc)
- editor of a newspaper, magazine – note that letters to the editor have word limits

You will be graded on the quality and depth of the research in the paper, not on the opinion or values expressed. You must present verifiable scientific info on a timely environmental issue, but consider your target audience (their knowledge level & attention span). Your research paper should back up the positions in your letter (ie, cite scientific sources & discuss logic—see TA in help session if you are unsure what constitutes a scientific source and logic). You may choose to provide info only, but we urge you to draw conclusions & take a stand: support your arguments with verifiable data & accepted scientific concepts. For topic ideas, see newspapers, newsletters/websites of groups working on environmental issues. Get help with your writing at: http://www.umt.edu/writingcenter/
Group research papers (about 5 pages per person) may earn extra credit, but require extra work.

CITE YOUR SOURCES!!!!!! Very important. Both to show that you really did some research and to avoid plagiarism—a that is, taking credit for the ideas or work of others. Plagiarism is grounds for failing the course and for dismissal from the university. Your research paper MUST include a list of references that
cites all your sources in scientific citation style (not in footnote style). Scientific citation style is described in this faculty pac, and your TA can explain it further. Remember to cite sources as you use them in the paper as well as collect them all together in a list at the end of the paper (alphabetized by lead author’s last name). See instructions for papers & citing sources.
C. PORTFOLIO – up to 50 points

You can earn up to 50 points by collecting together the work you’ve done in this class and evaluating it in a portfolio in order to demonstrate you’ve developed proficiency in Science Literacy. Read UM’s historic definition of ‘Natural Science Literacy’ in this FacPac. This states UM’s historic goals for science literacy among its graduates. The first section states a number of things that scientifically literate citizens can do. Write an essay (1) explaining how you increased your skills in each of these areas in this course; use examples from the work you did in the course (essay tests, letters, research papers, field trips, service projects, etc).

UM’s science literacy document then lists a number of desired outcomes for students. Write a short essay on each of these demonstrating your understanding of these concepts. Essays should be entitled:

2) The most critical concepts and processes of science I learned in Environmental Science
3) What are basic and applied environmental science, and how do they shape one another?
4) Science and technology — how have they harmed our environment? How can they help restore & protect it?

Your portfolio should be a 3 ring binder with dividers that includes the above 4 essays, all your exams, assignments, & any evaluations of these you are told to perform, including the one on community service. For each exam, rewrite your essays to demonstrate your knowledge of these subjects. Include your field trip reports.

Note — to receive credit for your portfolio, you must pick it up at the end of the semester.

FIELD TRIPS & CONFERENCES up to 80 pts

A large number of field trips will be offered early in the semester (subject to fire closures). Space in University vehicles is limited and will be allocated to those who sign up first. If space is full, a waiting list will be made. If you decide you cannot attend a field trip, notify instructor at least 48 hours in advance so others can be notified of available space. IF YOU DO NOT NOTIFY INSTRUCTOR, YOU WILL LOSE POINTS.

You can earn up to 10 points per hour of field trip time for a maximum of 80 pts. You must turn in a report to earn the points, and points received depend on the quality of the report. Reports should be about ½ page per hour. Reports should summarize the important technical info presented on the trip and relate these to concepts discussed in class. Reports should not simply say that you ‘learned a lot and thought the trip was great’. Take careful notes on a field trip to help you write a good report. Because of fires or bad weather, some field trips may be cancelled. If so, attendance at certain conferences may be substituted if pre-approved (proof of attendance required). Reports are due to your TA one week after the trip or conference. Students have failed for copying reports. Write your own.

E. PARTICIPATION/ATTENDANCE AT LECTURE AND HELP SESSIONS (up to 50 & 50 pts)

Students who attend lecture regularly get much more out of the course (or at least earn better grades). To encourage attendance, I will periodically request that a short essay question be answered in class. Those who regularly attend & turn in thoughtful essays will receive up to 50 additional points on their final grade.

Help sessions are intended to provide students with a place to interact in smaller groups with a discussion leader (the TA). Help sessions are a good place to discuss concepts or assignments that confuse you or topics that you feel have not received enough attention in class. Help sessions will also serve as exam review sessions and places to turn in assignments and receive graded work. Assignments will not be accepted or returned in lecture class — this is too disruptive. Help sessions should be used as open office hours with TAs. Students who actively participate in help sessions, those who regularly participate actively in help sessions will receive up to 50 additional points.
F. PRESENTATIONS ON PROJECTS – up to 30 pts

Students may give a presentation on your service and/or research projects near the end of the semester. Most will probably choose to give oral presentations, but you may develop a poster to display & you are encouraged to find a high visibility place to display it (such as a library or the mall). Or you may develop a web page on your project. Those who demonstrate to their TA that they can give an excellent oral presentation on their project may be asked to present to the entire class (but you may decline if you wish).
The course fac pac (available at the bookstore) clearly explains:
Lecture schedule, grading policy, texts, required reading & other assignments, exam schedules, office
hours and how to contact the class instructors.

Basic Class Etiquette
You should arrive before class starts and wait until class is over to depart. If you must arrive late, enter as
quietly as possible. If you must leave early, let the instructor know in advance and leave as quietly as
possible. Avoid scheduling conflicts that would cause late arrivals and early departures. When in class,
participate in class activities and avoid disrupting class by talking during lectures. Class etiquette is
especially important when guest speakers visit class. They are giving their time to you without pay; respect
that.
In help sessions, work with the TA to develop a respectful method of ensuring that all can participate in
discussion. Respect all viewpoints, including your own.

What constitutes a Pass for P/NP option?
Earn 60 % of possible points.

Attendance policy:
Attendance is occasionally taken in lecture (usually when guest speakers appear) and always taken in help
sessions. Regular attendance at lectures and active participation in help sessions earns points. Attendance is
taken by having students answer a short question about the lecture. To receive full credit, answers should
reflect that the student was present in mind as well as body.

Policy on making up exams: To make up an exam, student must contact Professor Watson soon after
missing the exam and explain reason for missing the exam (medical or personal emergency). If a student
misses either of the 2 mid term exams, the makeup exam is a comprehensive exam offered during the final
exam period for this course. Taking this exam is by appointment only.

Receiving an incomplete: To receive a grade of I or ‘incomplete’, student must request an incomplete and
explain what unexpected emergency made it difficult or impossible for the student to complete course work
by the due dates. Student must also agree to a date by which the work will be completed and turned in.
Some late work penalties will still apply.

Late work: As fac pac says, assignments lose half of their value for each week late. Hence, work that is 2
weeks late will receive no points. Extreme hardship cases may negotiate some reduction in late penalties
but will likely have to request an Incomplete if a large number of assignments must be handed in late.

What is the late drop policy for this course?
According to UM’s ‘Important Dates’ at
http://cyberbear.umt.edu/instructions/calendar_autumn_2008.htm:
The last day to add or drop online and receive refunds is Sept 15.
The last day to drop (or change grading system) without a refund and with only advisor & instructor
signatures is Oct 6 (after that, the Dean’s signature is required and fees are assessed). Professor Watson
does not require a reason for requesting a late drop, but the Dean probably will.
The VERY last day to drop is Dec 5 (last day of classes). After that, take your petition to God.
(this is known as the ‘drop dead’ drop deadline).

Expectations of Auditors -- Auditors must practice the same basic class etiquette as regular students. This
is the only expectation of unofficial auditors. Official auditors must attend class regularly (as evidenced by
in class essays) and answer the 4 essay questions described in the portfolio. Failure to meet these
expectations, will result in a notation in the student's academic record indicating that
attendance/participation was not satisfactory.
The Scientific Process
a) Briefly explain the steps of the scientific cycle as described in lecture (& p 19 of the fac pac). Illustrate each step with an example from environmental science. 13 pts
b) Briefly explain each of the following concepts used in the scientific process and give an example of each from environmental science (see p 20 of facpac): a scientific question, a hypothesis, a descriptive study, an experimental study, inductive logic, deductive logic, a reductionist approach & a holistic approach to studying an environmental problem. 13 pts
c) Briefly explain what is meant by the statement ‘correlation is not causation.’ Give an example. 2 pts
d) Why does environmental science rely on the preponderance of the scientific evidence rather than ‘proof.’ 2pts

Critical Thinking
a) Describe the essential elements of the Critical Thinking process as described on p 15 & 16 of your fac pac. (20pts)
b) List and briefly explain 5 scientific principles and 5 philosophical principles from Miller’s Principles for Understanding & Working with the earth (p 13 & 14 of the fac pac). 10 pts
c) How do you distinguish a scientific principle from a philosophical principle? 2 pts
d) Which of the 2 types of principles is most important in making environmental decisions? 2 pts

C. World Scientists Warning (p 17 of facpac)
a) 6 pts. List the 7 problem areas identified by the World Scientists Warning to Humanity.
b) 6 pts. State the 5 actions they called for to address these problems.
c) 4 pts. Who did the scientists call on to act (both in general and more specifically)? Why should the views of these scientists carry weight?
d) 10pts. What additional problems or actions would you add to the list given by the world scientists? Explain why. What problems or actions would you subtract from their list because you don’t agree with them. Explain why. It is OK to give philosophical reasons, but points are awarded only for valid scientific reasons. Be sure to state which of your reasons are philosophical and which are scientific reasons.
e) 4 pts. How can you personally act on your recommended actions?

D. Ecosystem Services
a) 10pts. What is meant by an ecosystem service? Briefly explain at least 8 examples of ecosystem services from Gretchen Daily’s paper (on e-reserve) or from the Ecological Society’s web site (www.esa.org/ecoservices).
b) 10 pts. Select either pollination OR water purification. Explain how ecosystems provide this service and how humans are benefitted by the service. What would it cost to provide this service artificially?
c) 10 pts. What interferes with this service? What can we do to protect this service?

Ecosystem Connections
a) The abundance & diversity of life in an ecosystem depends on the efficiency of energy capture & transfer up the food chain. Explain this statement. 8 pts
b) Explain some of the main ways humans affect these efficiencies. 8 pts
c) Explain the main ways that humans affect sedimentary cycles and atmospheric cycles. Give an example of each kind of cycle. 6 pts
d) What are some of the important ways in which the parts of ecosystems are connected? 6 pts
e) What is meant by the statement – “You cant do just one thing – our actions have unexpected, indirect effects.” 2pts

F. Water Cycle
a) 10 pts. List the 8 ways that humans alter the water cycle (according to p22 of the fac pac).
For each of these 8 ways, briefly describe what you consider to be the main negative effects on the Clark Fork River (and/or its tributaries & aquifers) – according to the online slide show on the Clark Fork River Basin (www.umt.edu/clarkforkslideshow).
Remember that adding chemical pollution to the water does not alter the water cycle, unless it actually changes the movement or levels of the water. SO DONT TALK ABOUT CHEMICAL POLLUTION unless you can show that it has altered water movement or level or that an alteration of the water cycle has made the chemical pollution problem worse (as it has at Milltown).
b) 10 pts. Water cycle changes have profoundly affected the Clark Fork in the following ways: 1) changed habitat and biodiversity; 2) changed river productivity, 3) changed material cycles and 4) affected human use of water resources. For each of these 4 types of effects, state which of the 8 types of water cycle change you feel has most negatively affected this aspect of the river and explain what the effect has been. How do you think this effect could be reversed or reduced? What can you do personally to reduce the effects of water cycle change on the Clark Fork?

c) 10 pts – Indicate which chapter you read in the Alice Outwater book and briefly summarize how that chapter explained how humans have changed the water cycle and some of the resulting effects on humans and other life forms.

Community Concepts
a) Define competition, predation & symbiosis. What is meant by the statement: “Every species plays multiple roles in its community”? 4 pts
b) Explain what is meant by each of the following terms & how we can use information from these species to better conserve communities: indicator species, umbrella species, keystone species. Give an example of each. 6 pts
c) What is the importance of each of these kinds of interactions to the overall productivity and diversity of their community: Ruminants & their gut bacteria, N fixing bacteria & legumes, mycorhizza, lichens, coral. 10 pts
d) Why do some exotic species do poorly when introduced to a new community while others outcompete native species? What are the advantages and disadvantages of using specialists & generalists for biocontrol? 2 pts
e) What is meant by disturbance? What general pattern does a community follow after a major disturbance? How can disturbance reduce biodiversity? How can it increase biodiversity? 8 pts

Species & Populations
a) Define species, population, gene pool and evolution. 8 pts
b) Briefly explain the processes that cause changes in gene pools 10 pts.
c) Why is genetic diversity important to a species’ chances of survival? 2 pts
d) What characteristics make a species extinction prone? 10 pts (use Miller’s index to find)

Biodiversity
a) Explain each of these kinds of biodiversity: habitat diversity, species diversity, genetic diversity. 3 pts
b) What are the 4 greatest threats to biodiversity according to the article in Bioscience presented in lecture? 4 pts
c) Which community types are most threatened and why? 8 pts
d) What are some reasons it is important to maintain biodiversity? 5 pts
e) What are the important parts of a strategy to maintain biodiversity? That is, how do we maintain biodiversity? 10 pts

Population growth, regulation, and carrying capacity
a) Explain what kinds of factors determine how fast a population can grow? (i.e., what determines rate of growth r?) 8 pts
   include characteristics of the species and of its environment that affect r.
b) Explain what kinds of factors determine how large a population can grow? (i.e., What determines carrying capacity K?) 8 pts
   include characteristics of the species and of its environment that affect K.
c) What is meant by living on Earth Capital vs living on Earth Interest? 2 pts
d) What is meant by ‘sustainable use of resources & ecosystems”? Explain a resource example & an ecosystem example. 4 pts.
   What is meant by unsustainable use, that is, ‘degrading, depleting or mining a resource or ecosystem’?
   Explain a resource example and an ecosystem example of unsustainable use. 4 pts.
e) Explain what Garret Hardin means by cultural carrying capacity (see fac pac or http://dieoff.org/page46.htm) 4 pts

Ecological Footprint
Discuss the concept of the Ecological Footprint as described in the fac pac or by the website Redefining Progress (www.rprogress.org), or in the book of that name. Indicate which source you are using. Address the following: a) 6 pts. What is meant by your Ecological Footprint and your Earth Share?
b) 6 pts. How are these estimated? What human demands on the earth were considered?
c) 6 pts. How big is the average US citizen’s Ecological Footprint and how does it compare to our ‘earthshare’?
d) 6 pts. How many planets would be required to support earth’s current population at the US lifestyle?
e) Explain what Garret Hardin means by cultural carrying capacity (see fac pac or http://dieoff.org/page46.htm) 4 pts
e) 6 pts What changes in your lifestyle would do the most to bring your footprint closer to your earthshare?

**Tragedy of the Commons by Garrett Hardin (full article at http://dieoff.org/page95.htm)**

a) According to this article, what are the main causes of environmental problems & how can they be addressed? 10 pts

c) What sorts of resources are held in common? Which sorts are usually held as private property? 4 pts

d) Explain examples of the Tragedy of the Commons that you have seen. 2 pts for each good example up to 10 pts.

e) How do you think the Tragedy of the Commons can be reversed? 6 pts