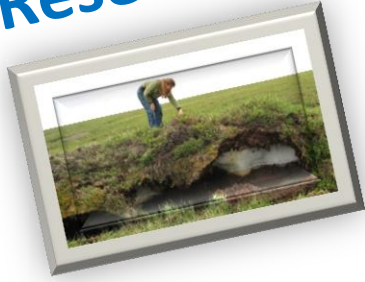




Research

Education



**Department of Watershed Sciences
Self-Study for Program Review
January 2012**



Extension



DEPARTMENTAL PROFILE

Watershed science is the study of the physical, chemical, and biological processes inherent in the movement of water across the landscape. Understanding the interactions among water, earth materials, and biota is essential to the management of undisturbed, agricultural, and urban ecosystems. In this self-study we document our goals, methodologies, and accomplishments that allow us to succeed in teaching, research, and extension to promote effective stewardship of watershed ecosystems. We also document challenges that impinge on our effectiveness in accomplishing these goals.

The Department of Watershed Sciences at Utah State University strives to bring interdisciplinary approaches to the study of watersheds in Utah and western North America. We seek to understand how watersheds function through our research programs. We use the knowledge acquired in this research to design and implement management policies and practices to solve societal problems that related to aquatic systems. And we educate the next generation of aquatic scientists and educators through our undergraduate and graduate degree programs. Infused throughout our research and educational initiatives are efforts to extend our knowledge to state, federal, and non-governmental land-management agencies to assist them in their efforts to manage natural resources and foster ecosystem health.

The goals of our research, teaching, and extension programs are three-fold. First, we strive to assess the status of aquatic and watershed resources. Secondly, we work to preserve intact natural ecosystems. Thirdly, we develop means to restored degraded watersheds to enhance ecosystem services and environmental quality for the good of society.

To accomplish these goals we have hired an interdisciplinary group of aquatic ecologists, hydrologists, geomorphologists, and geographers to direct integrated analyses of the status and trend of the nation's aquatic environments. Our Watershed Sciences department is unique among academic programs in consciously bringing together physical, chemical, and biological scientists to focus on issues in water science. We are committed to studying watersheds as integrated systems, and as such, require deep understanding of the physical template of different landscapes, the relationship among organisms and their environments, and the impact of organisms on the physical landscape. We integrate the physical, chemical, and biological components of these complex systems through state-of-the-art spatial analyses. The current demands of society on our science to make accurate and relevant predictions make it paramount that we also integrate our knowledge in simulation models of future conditions and retrospective analyses of the past.

Our mission is to foster the discovery, learning, and application of knowledge about aquatic and earth resources and their related ecosystems to promote stewardship of the environment. This mission demands the development of relevant research endeavors to enhance our understanding of ecosystems, rigorous educational programs to produce the next generation of scientists and managers, and effective extension and outreach programs that are responsive to public needs. Promotion of a dedicated faculty and staff, recruitment of talented and motivated students, and creation of a stimulating and supportive departmental environment are central to these pursuits.

ACADEMIC DEGREE PROGRAMS

The Department of Watershed Sciences offers three undergraduate degrees: BS in Fisheries and Aquatic Sciences (BS-FAAS), BS in Watershed and Earth Systems (BS-WAES), and BS in Geography (BS-GEOG, co-administered with the Department of Environment and Society). We offer graduate degrees in Fisheries Biology (MS and PhD), Watershed Science (MS and PhD), Ecology (MS and PhD), and we participate in the Master of Natural Resources degree program administered in the College of Natural Resources.

The goals of our educational programs derive from our departmental mission statement (see inset box). In our undergraduate degree programs we have three main teaching goals:

- 1. To educate students in the methods and skills of watershed sciences;**
- 2. To train and educate the next generation of watershed managers;**
- 3. To instill the interdisciplinary knowledge necessary for students to work effectively with a variety of interest groups to inform water policy in our country.**

In our graduate degree programs we augment these three teaching goals with a fourth goal:

- 4. To address relevant scientific and societal questions by conducting original research using state-of-the-art analytical tools and methods.**

Our teaching mission is accomplished through the delivery of both undergraduate and graduate degree programs. The Bachelor of Science degrees were created in 2003 when our department was formed during the most recent reorganization of the College of Natural Resources. The number of majors in these programs is small but growing. The market analysis we conducted in 2005 suggested that jobs for BS graduates in the fields of fisheries, geography, and watershed sciences would be limited, but that opportunities for persons with graduate degrees were growing at a high rate. Our efforts are focused on achieving excellence in education so that new BS students compete effectively for important and prestigious positions with government agencies, environmental firms, and non-governmental organizations. Our very best undergraduate students compete well in their efforts to continue their education in some of the best graduate programs in the United States. We place almost all of our

graduate degree recipients in high quality positions with federal and state governments, academic institutions, and private firms serving the environment. We believe that we excel in providing outstanding educational experiences for our students, as evidenced by placement and alumni surveys of our graduates. See the Program Assessment section of this report for details on the placement of students completing our degrees.

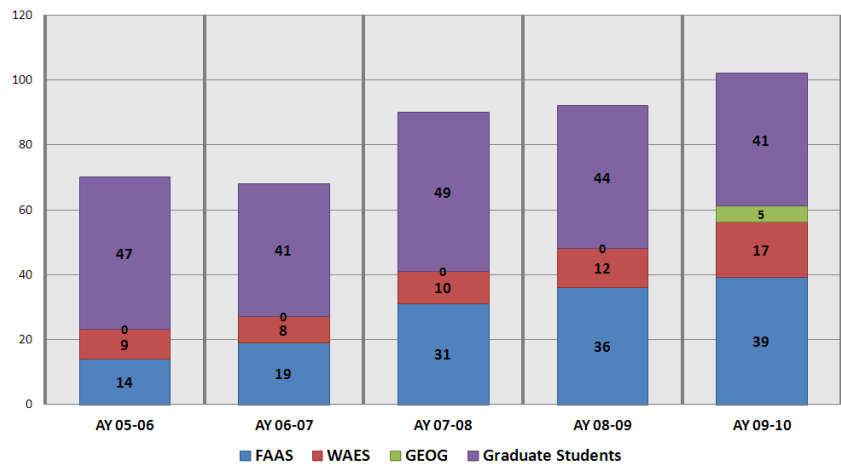


Figure 1. Undergraduate majors and graduate students in the Department of Watershed Sciences from 2006-2011.

We have a small but growing number of undergraduate majors in the Fisheries and Aquatic Science (FAAS) and Watershed and Earth Systems (WAES) Bachelor of Science degree programs. During the past five years our numbers of undergraduate majors have doubled to almost 60 students (Figure 1). Approximately two-thirds of our undergraduates pursue the BS degree in FAAS. Our number of graduate students has increased to over 50 students. Faculty maintain prominent research programs and are encouraged to involve graduate students in these research projects. Faculty members in WATS mentor an average of 4-5 graduate students.

Undergraduate Academic Programs

We strive for excellence in our academic program by forcing students to develop a set of skills needed by students entering professions in watershed sciences. We accomplish this by establishing specific learning objectives for each of the required courses in the curricula, and through the integration of these learning objectives in the series of courses leading to student capstone experiences. The overall learning objectives for our degree programs are presented below.

Learning objectives common to our three BS degrees

Ability to assess human impacts on earth systems

Analysis of services ecosystems provide

Writing competence for science applications

Oral communication skills

Statistical competence in ANOVA and regression analyses

Competence in interpretation and development of geographical analyses

Competence in interpretation of remotely sensed data

A description of the three BS degree programs follow. Complete listings of course requirements are listed in Appendix 1.

BS degree in Fisheries and Aquatic Sciences. The first two years of the Fisheries and Aquatic Sciences curriculum include courses designed to give students a sound scientific background, an introduction to the field of natural resources management, and an introduction to aquatic and earth resources. Students attaining the BS in Fisheries and Aquatic Sciences will have strong quantitative skills; an understanding of the interactions of the physics, chemistry, and biology inherent in aquatic ecosystems; the knowledge necessary to manage freshwater fish populations; and be versed in geographic information analysis.

There are currently 29 undergraduate students enrolled in the Fisheries and Aquatic Sciences major. Their average GPA is 2.8. The course requirements for this degree are listed in Table 1. The learning objectives associated with this degree are presented below.

Learning objectives specific to the Fisheries and Aquatic Sciences Degree

Learning principles of the biology of aquatic organisms

Gaining knowledge of habitat requirements of aquatic organisms

Application of biological principles to analyze population dynamics

Critical assessment of human impacts on biodiversity

Develop skills in measurements of abundance, biomass, growth of organisms

Table 1. Fisheries and Aquatic Sciences Course Requirements. All USU students also complete the general education requirements. Students also complete 21 credits in approved elective courses.

A. Scientific Foundation (35 credits)			
Must complete all of the following:		Cr.	
<input type="checkbox"/>	BIOL 1610	Biology I	4
<input type="checkbox"/>	BIOL 1620 (BLS)	Biology II	4
<input type="checkbox"/>	CHEM 1210	Principles of Chemistry	4
<input type="checkbox"/>	CHEM 1215	Chemical Principles Laboratory I	1
<input type="checkbox"/>	CHEM 1220 (BPS)	Principles of Chemistry II	4
<input type="checkbox"/>	CHEM 1225	Chemical Principles Laboratory II	1
<input type="checkbox"/>	MATH 1050 (QL)	College Algebra	4
<input type="checkbox"/>	MATH 1100	Calculus Techniques	3
<input type="checkbox"/>	NR 2220	General Ecology	3
<input type="checkbox"/>	PHYS 2110	General Physics - Life Sciences I	4
<input type="checkbox"/>	STAT 3000 (QI)	Statistics for Scientists	3

B. Common Departmental Core (21 credits)			
<input type="checkbox"/>	ENVS 4000 (DSS)	Human Dimensions of NR Management	3
<input type="checkbox"/>	GEOG 1800	Introduction to Geographic Information Sciences	3
<input type="checkbox"/>	WATS 1020	Watershed Sciences Professional Orientation	1
<input type="checkbox"/>	WATS 3700 (CI)	Fundamentals of Watershed Science	3
<input type="checkbox"/>	WATS 4490	Small Watershed Hydrology	4
<input type="checkbox"/>	WATS 4500	Limnology: Ecology of Inland Waters	3
<input type="checkbox"/>	WATS 4930	Advanced GIS and Spatial Analyses	3
<input type="checkbox"/>	WATS 4980	Watershed Sciences Departmental Seminar	1

C. Fisheries Courses (15 credits)			
<input type="checkbox"/>	WATS 3100 (CI)	Fish Diversity and Conservation	3
<input type="checkbox"/>	WATS 3110	Fish Diversity Laboratory	1
<input type="checkbox"/>	WATS 4310	Wetland Ecology and Management	3
<input type="checkbox"/>	WATS 4650	Principles in Fishery Management	3
<input type="checkbox"/>	WATS 5200	Fish Habitats	2
<input type="checkbox"/>	WATS/BIOL 5550	Freshwater Invertebrates	3

D. Capstone Experience (3 credits minimum)			
<input type="checkbox"/>	WATS 4510	Aquatic Ecology Practicum	3
<input type="checkbox"/>	Approved Natural Resources Capstone Experience		3

BS degree in Watershed and Earth Systems. Students attaining the BS in Watershed and Earth Systems will have strong quantitative skills; be versed in geographic information analysis; and have an understanding of the interactions of the physics, chemistry, and biology inherent in earth ecosystems.

There are currently 16 undergraduate students enrolled in the Watershed and Earth Systems major. Their average GPA is 2.9. The courses required to complete this degree are described in Table 2. The learning objectives associated with this degree are presented on the next page.

Table 2. Watershed and Earth Systems Course Requirements. All USU students also complete the general education requirements. Students also complete 33 credits in approved elective courses.

A. Scientific Foundation (18 credits)			
Must complete all of the following:		Cr.	
<input type="checkbox"/>	CHEM 1210	Principles of Chemistry	4
<input type="checkbox"/>	GEO 1110 (BPS)	Physical Geology	3
<input type="checkbox"/>	MATH 1210 (QL)	Calculus I	4
<input type="checkbox"/>	STAT 3000 (QI)	Statistics for Scientists	3
<input type="checkbox"/>	PHYS 2210 (QI)	General Physics - Science and Engineering I	4

B. Common Departmental Core (21 credits)			
<input type="checkbox"/>	ENVS 4000 (DSS)	Human Dimensions of NR Management	3
<input type="checkbox"/>	GEOG 1800	Introduction to Geographic Information Sciences	3
<input type="checkbox"/>	WATS 1020	Watershed Sciences Professional Orientation	1
<input type="checkbox"/>	WATS 3700 (CI)	Fundamentals of Watershed Science	3
<input type="checkbox"/>	WATS 4490	Small Watershed Hydrology	4
<input type="checkbox"/>	WATS 4500	Limnology: Ecology of Inland Waters	3
<input type="checkbox"/>	WATS 4930	Advanced GIS and Spatial Analyses	3
<input type="checkbox"/>	WATS 4980	Watershed Sciences Departmental Seminar	1

C. Watershed and Earth Systems Courses (15 credits)			
<input type="checkbox"/>	PSC 3000	Fundamentals of Soil Science	4
<input type="checkbox"/>	WATS/PSC 3820 (QI)	Climate Change	3
<input type="checkbox"/>	WATS/GEO 5150	Fluvial Geomorphology	3
<input type="checkbox"/>	WATS/GEO 5170	Fluvial Geomorphology Lab	2
<input type="checkbox"/>	WILD 5750	Applied Remote Sensing	3

D. Capstone Experience (2 credits minimum)			
<input type="checkbox"/>	WATS 4510	Aquatic Ecology Practicum	3
	WATS 4530	Water Quality and Pollution	3
	WATS 4931	GIS Research Projects	2
	Approved Natural Resources Capstone Experience		2-3

Learning objectives specific to the Watershed and Earth Systems Degree*Develop competence in hydraulics and sediment transport in streams**Develop ability to make measurements of stream discharge, hydraulic forces, channel features**Application of remotely sensed data to analyze environmental problems*

BS Degree in Geography. The Physical Geography emphasis in the BS-GEOG degree focuses on physical processes on a landscape scale. Students gain proficiency in geographic information sciences and are exposed to processes of landscape geomorphology and hydrology. Students completing this emphasis will have strong quantitative skills, will be versed in spatial analysis, and will gain an understanding of the interactions of the physics, chemistry, and biology inherent in earth ecosystems. This emphasis draws upon the disciplinary strengths of the Watershed Sciences Department. The requirements for the Physical Geography emphasis to the BS in Geography degree are listed in Table 3. The learning objectives associated with this degree are presented below.

Learning objectives specific to the Geography Degree, Physical Geography Emphasis*Learn fundamental concepts in physical geography**Develop skills to collect and analyze geographic field data**Learning fundamental concepts of earth systems and interactions*

Table 3. Physical Geography Emphasis Course Requirements. All USU students also complete the general education requirements. Students also complete 24 credits in approved elective courses.

A. Common Departmental Core (15-16 credits)			
<input type="checkbox"/>	ENVS 3330	Environment and Society	3
<input type="checkbox"/>	GEOG 1000	Physical Geography (BPS)	3
<input type="checkbox"/>	GEOG 1005	Physical Geography Lab	1
<input type="checkbox"/>	GEOG 1300	World Regional Geography (BSS)	3
<input type="checkbox"/>	GEOG 1800	Introduction to Geographic Information Sciences	3
<input type="checkbox"/>	GEOG 1990	Professional Orientation for Geography	1
B. Physical Geography Courses (36-37 credits)			
<input type="checkbox"/>	MATH 1100	Calculus Techniques (QL)	3
<input type="checkbox"/>	MATH 1210	Calculus I (QL)	4
<input type="checkbox"/>			
<input type="checkbox"/>	PSC 3000	Fundamentals of Soil Science	4
<input type="checkbox"/>	STAT 3000	Statistics for Scientists	3
<input type="checkbox"/>	WATS 3700	Fundamentals of Watershed Science	3
<input type="checkbox"/>	WATS 3820	Climate Change (DSC/QI)	3
<input type="checkbox"/>	WATS 4490	Small Watershed Hydrology	4
	WATS 4930	Geographic Information Systems	4
<input type="checkbox"/>	Two courses chosen from the Human-Environment Geography core		6
<input type="checkbox"/>	Two courses chosen from the Geographical Analysis and Bioregional Planning core		6

Capstone Courses

The skills and abilities students learn in the undergraduate courses culminate in the capstone courses where students synthesize information on the physical, chemical, biological and social science aspects of watershed science to effectively identify and analyze a problem that is pertinent to our region. The details of these exercise vary from year to year based on the problem or issue examined. The Aquatic Ecology Practicum (WATS 4510), Water Quality and Pollution (WATS 4530), and Geographic Information Systems (WATS 4930) serve as capstone courses for the FAAS, WAES, and GEOG BS degrees. During this past year students in the Aquatic Ecology Practicum conducted an evaluation of the state of excess nutrient loading on the ecology of Cutler Marsh. Students in the Water Quality and Pollution course assessed how various land uses impact the amount of nutrients entering the Cub River in northern Cache Valley. Students in the Geographic Information Systems class did independent research projects by working in small groups. In other years these courses have focused on issues related to fish distribution in the freshwater bays of the Great Salt Lake, the nutrient loadings in the Bear River hydrologic system, patterns of biodiversity along a trophic gradient in Lake Powell, and the impact of sewage treatment facilities in Farmington Bay of the Great Salt Lake. These capstone courses embody our approach to linking discovery, creativity, and engagement with faculty and other students. A selection of the work completed in these courses is summarized below. Complete reports from these class exercises are presented in Appendix 2.

Summaries of recent capstone courses.

Limnological Analyses of Cutler Reservoir and Dingle Marsh with Respect to Eutrophication (WATS 4510)– In September, 2009, students in Dr. Wayne Wurtsbaugh’s Aquatic Ecology course began a series of projects to better understand ecological and limnological characteristics of Cutler Reservoir near Logan. Dr. Wurtsbaugh’s classes from previous years analyzed limnological characteristics of Cutler Reservoir and Dingle Marsh. Results from these studies indicated that Cutler Reservoir was an ecosystem highly impacted by urban pollution. The group of students examined specific consequences of the sewage treatment outlet by sampling along a gradient of sites in the reservoir. Specific student projects were quite diverse ranging from an examination of the change in biotic components with distance from the sewage outlet, to assessment of diel oxygen dynamics associated with macrophyte beds, to a stable isotope analysis of food web dynamics.



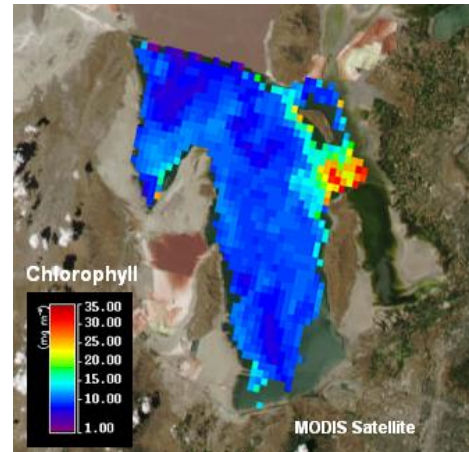
Total Maximum Daily Load (TMDL) Report for the Little Bear River Watershed, Cache Valley, Utah

(WATS 4530)– The Federal Clean Water Act (CWA) requires every state to establish and maintain water quality standards designed to protect, restore and preserve water quality within the state. When a water body, i.e. lake, river, or stream, fails to meet the water quality standards for its designated use, section 303(d) of the CWA Act requires the state to list that water body as impaired and prepare a TMDL. This class used temporal and spatial datasets collected by different agencies as well as field data collected by the class to assess current water conditions, calculate a TMDL for a local waterbody, and develop a management plan based on these analyses.



Impact of the Farmington Bay Eutrophication Plume on the Plankton Ecology of Gilbert Bay, Great Salt Lake–WATS 4510)

The Great Salt Lake is a saline lake that is divided into several different bays. High densities of algae in Farmington are the result of effluents discharged from several wastewater treatment plants. These high levels of algae create a large algal plume that extends several kilometers out into Gilbert Bay that can be seen from satellites. This study focused on how algal biomass and the brine shrimp grazers differed between the two bays and along the plume. Water samples were taken at seven different sites and then later processed in the laboratory. Primary production was measured in the laboratory with water from Farmington Bay and from Gilbert Bay by recording the change in oxygen that occurred during photosynthesis and respiration. Both chlorophyll and primary production decreased the farther away the site was from Farmington Bay. An isotopic analysis of carbon and nitrogen indicated that brine shrimp in Gilbert Bay utilize the high algal biomass exported from Farmington Bay, but a laboratory experiment demonstrated that high concentrations of Farmington Bay algae were toxic to the shrimp.



Geographic Information Analyses (WATS 4930): Capstone report summaries from students

Reaching the Majority of the Minorities in Cache Valley: A Network Analysis, by Jordan Behunin

This report provides a solution to a problem through the use of a tool within a geographic information system software called ArcGIS. The tool within ArcGIS is called the Network Analyst Tool. The English Language Center (ELC) of Cache Valley, Inc. is a non-profit school with the mission to help all non-fluent speakers of English improve their ability to survive in an English speaking society. The ELC works with adult students from all over the world who are living here in Cache Valley. In order to assist these potential students, the ELC works through mediums of radio and distributing flyers to schools where adult immigrants' children go to learn, stores, employers, restaurants, and businesses where potential adult students may be. Distributing flyers to these target places in the community, has



Graduate Degrees

The Department of Watershed Sciences offers MS and PhD degrees in Ecology, Fisheries Biology, and Watershed Sciences. The Ecology degrees are interdisciplinary in that the degree program is administered by the Ecology Center at USU. Course and research requirements for MS and PhD degrees in Ecology are determined by a committee of Ecology Center faculty. These faculty belong to departments in the College of Natural Resources, College of Science, and College of Agriculture. Table 4 lists these requirements.

Table 4. Ecology Center Degree Requirements

Ecology Seminar - enroll once per year
MS student are required to take one course each from two of the four blocks
PhD students are required to take one each from three of the blocks
Block 1 – Biophysical Ecology
Block 2 – Organismic, Populations, and Evolutionary Ecology
Block 3 Community, Ecosystem, and Landscape Ecology
Block 4 Quantitative Ecology

MS and PhD degrees in Fisheries Biology focus on educating students in the principles of the biology of fishes and the practice of fisheries management. Recent advances in our understanding of genetics, physiology, and evolution have profound implications on how fish taxa are influenced by their environment and how fish populations impact the communities and ecosystems they inhabit. Students graduating with advanced degrees in Fisheries Biology have strong backgrounds in general scientific approaches, statistical rigor, and a deep understanding of the biology of aquatic organisms. Development of new sampling and analysis technologies such as stable isotopes, simulation modeling, organismal tagging, and GIS have allowed our students to better assess the role of aquatic organisms within the context of their ecosystems and have enhanced our ability to embrace the management of biodiversity at large spatial scales.

MS and PhD degrees in Watershed Sciences focus on the physical and chemical changes to our environment and how human activities influence these changes. Students in these programs learn to assess the current condition of our watershed resources and determine the direction and magnitude of changes to these ecosystems. Students completing these advanced degrees are proficient at measuring the scale of environmental change in atmospheric, hydrologic, and geomorphic arenas. The synergies inherent in the dynamics of these areas coupled with their impact on biologic resources are important components of our graduate education programs. Students in these degree programs become fully embedded in our rapidly changing ability to understand environmental changes based on the development of finer scale geographic instrumentation, greater precision in determining the condition of past environments, and heightened abilities to predict the future conditions of our planet's environments. Students in the Watershed Science degree programs are at the cutting edge of our ability to assess changes in the environment, design plans to restore degraded ecosystems, and assess these efforts to conduct ecosystem restoration.

We expect that students in each of the graduate degree programs will make new contributions to the science and management of watershed resources. All graduate students in the department are required to complete a pre-project research proposal for their committee's approval. Dr. Charles Hawkins assists students in the preparation of this proposal during the Communicating Science course taught during the

first part of Spring Semester. Beginning graduate students in each of the MS and PhD programs present their pre-project proposal to the department during the annual Graduate Student Symposium each March. Table 5 contains the schedule for the symposium held in 2011. Appendix 3 contains the abstracts of the presentations from this past year. The presentations in in this symposium provide each student with helpful feedback from the faculty and other students in the department and also serves to inform all faculty and graduate students of the research being conducted in the various research labs. This intense initial focus on student research projects helps students in their preparation for beginning field and laboratory work. We encourage the publication of student research projects having students complete their theses and dissertations in formats suitable for submission to research and management journals. This approach has helped many students begin their publishing careers and gives them an advantage when pursuing employment or additional graduate education. Figure 2 provides a sampling of the research publications of our recent graduates.

Table 5. Spring 2011 Graduate Student Symposium Participants and Presentation Titles

Ryan Hill, PhD Student Update (Hawkins)	Effects of Natural and Altered Catchment Attributes on Stream Temperatures of the Western USA
Tracy Bowerman, PhD Student Update (Budy)	Use of a Site-specific Metapopulation Model to Assess Potential Threats to an Imperiled Freshwater Fish.
Erika Hegeman, MS Student (Miller)	Modeling Freshwater Mussel Distribution Patterns in Relation to Biotic and Abiotic Factors In The Middle Fork John Day River, Oregon
Jacob Vanderlaan, MS Student (Hawkins)	Tracing Aquatic Stressors from Watershed Scale Sources to Local Water Chemistry and Benthic Macroinvertebrate Assemblage Alterations in Nevada Streams
Stephen Klobucar, MS Student (Budy)	An Experimental and Modeling Approach to Predator-Prey Dynamics: Identifying Limitations of Predator Performance in High Desert Impoundments
John Olson, PhD Student Update (Hawkins)	Predicting Natural, Site-Specific Nutrient Concentrations in Western USA Streams
Eric McCulley, MS Student (Wurtsbaugh)	Implementing, and Maintaining Riparian Habitat Restoration Projects Along the Jordan River, Utah
Justin Stout, MS Student (Belmont)	Sediment Fingerprinting for Sources and Transport Pathways in the Root River
Ripley McCoy, PhD Student (Jin)	Improved Dynamical Downscaling of Regional Climate for the Western United States
Ryan Lokteff, MS Student (Wheaton)	The Effects of Physical In-Stream Environment on Habitat Utilization and Interspecies Competition on Bonneville Cutthroat Trout
Lindsey Goss, MS Student (Roper)	Livestock Disturbance Protocols: Understanding the Relationship Between Bank Alteration and Stream Conditions
Sara Bangen, MS Student (Wheaton)	Quantifying Stream Habitat: Relative Effort versus Quality of Remote Sensing & Ground-Based Survey Techniques
Alan Kasprack, PhD Student (Wheaton)	Morphodynamic Modeling of Gravel-Bed River Evolution: Innovations and Applications
Eric Hazelton, PhD Student (Kettenring)	<i>Phragmites australis</i> in the Chesapeake Bay: Interactions between Environment, Land-Use, Restoration and Genetics

- Marcarelli, A.M. and W.A. Wurtsbaugh. 2006. Temperature and nutrient supply interact to control nitrogen fixation in oligotrophic streams: an experimental examination. *Limnol. Oceanogr.* 51:2278-2289.
- Grams, P. E., Schmidt, J. C., and Topping, D. J., 2007, The rate and pattern of bed incision and bank adjustment on the Colorado River in Glen Canyon downstream from Glen Canyon Dam, 1956-2000. *Geological Society of America Bulletin* 119(5): 556-575.
- McHugh, P., P. Budy, G.P. Thiede, and E. VanDyke. 2008. Trophic relationships of nonnative brown trout, *Salmo trutta*, and native Bonneville cutthroat trout, *Oncorhynchus clarkii* utah, in a northern Utah, U.S.A. river. *Environmental Biology of Fishes* 81:63-75.
- Homel, K., P. Budy, M.E. Pfrender, T.A. Whitesel, and K. Mock. 2008. Evaluating genetic structure among resident and migratory forms of bull trout (*Salvelinus confluentus*) in Northeast Oregon. *Ecology of Freshwater Fish*, Online Early Articles: doi:10.1111/j.160-0633.2008.00299.x.
- Wood, J. and P. Budy. 2009. An investigation of the early life-history and potential influences on invasion success of exotic brown trout (*Salmo trutta*). *Transactions of the American Fisheries Society* 138:756-767.
- Dean, D. J., and Schmidt, J. C., 2010, The role of feedback mechanisms in historic channel changes of the lower Rio Grande in the Big Bend region. *Geomorphology*, doi: 10.1016/j.geomorph.2010.03.009
- Hein, C. L., A. S. Pike, J. F. Blanco, A. P. Covich, F. N. Scatena, C. P. Hawkins, and T. A. Crowl. 2010. Geomorphic barriers structure diadromous faunal communities in tropical island streams. *Freshwater Biology* (doi:10.1111/j.1365-2427.2010.02537.x).
- Johnson, C.R., C. Luecke, S.C. Whalen, and M.A. Evans. 2010. Direct and indirect effects of fish on pelagic nitrogen and phosphorus availability in oligotrophic Arctic Alaskan lakes. *Can. J. Fish. Aquat. Sci.* 67:1635-1648.
- Hein, C.L., A.S. Pike, J.F. Blanco, A.P. Covich, F.N. Scatena and T.A. Crowl. In Press. Geomorphic barriers override land use effects on diadromous faunal communities in tropical island streams. *Ecological Applications*.
- Olson, J. R., and C. P. Hawkins. Predicting natural base-flow stream water chemistry in the western United States *Water Resour. Res.*, doi:10.1029/2011WR011088, in press.

Figure 2. A sampling of Research Publications from Recent Graduates of the MS and PhD programs. During the past six years graduate students in our program have published 84 papers in peer-reviewed journals.

Figure 3 (on the following page) shows the number of students enrolled in each of our graduate degree programs. Our graduate student population size has remained about the same for the past five years. Most of our faculty are presently supervising 3-6 graduate students. Efforts to increase the number of students in these research-based degree programs will likely depend on increasing the number of faculty as most faculty have fully staffed graduate research programs.

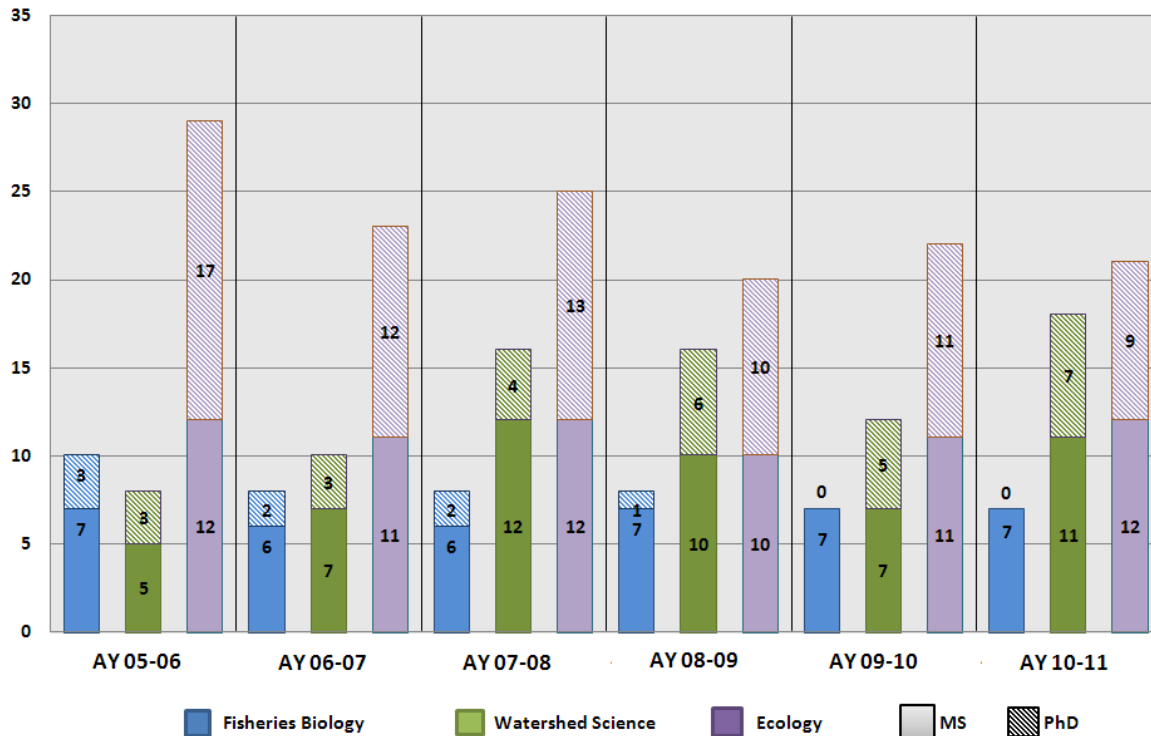


Figure 3. WATS graduate headcount enrollment. Each degree program is presented in a different color. The MS and PhD student numbers for each degree are presented as the lower and upper portion of the histogram bar. MNR students are not included in this tally.

In addition to these research-based graduate degrees, we also contribute to the teaching and advising of the Master of Natural Resources degree program. This coursework-focused Master's program is designed for students who have had or are currently employed by natural resource agencies and is administered by the College of Natural resources. Enrollment in this program is growing at a very rapid rate and has made it difficult to maintain the course offerings and advising personnel. The program has had a tremendous success in allowing us to influence the educational background of state agency personnel in Utah and the western United States. The growing pains exhibited by this program demonstrate the need of agencies to enhance the education of their science and management staff. The department of Watershed Sciences needs to determine how to effectively contribute to this program without sacrificing efforts in our traditional programs in graduate education.

We strive to encourage innovation in our graduate degree programs. Our faculty understand the need for an interdisciplinary approach to the training and education of the next generation of aquatic scientists and resource managers. Two examples of these types of innovations involve the initiation of a new course called "Graduate Induction into Watershed Sciences" and a new emphasis in our Watershed Science degree call "Geomorphology and Earth Surface Processes".

The Graduate Induction course is a five-day intensive class required of incoming graduate students. This fall 13 students and two faculty leaders examined watershed issues by working with many of the faculty on research programs centered in our home watershed, the Bear River in northern Utah. Students began this course in the lower portions of the watershed by examining water quality information as related to land use practices in the urban and semi-rural areas of Cache Valley. This part of the class culminated in a short-term bioassay experiment of nutrient limitation in Cutler Reservoir. (Figure 4). The

class then moved up the watershed through various reaches of the Logan River and associated tributaries to measure geomorphic changes due to beaver activity, examine cutthroat trout populations for marked individuals, and measure results of a stream restoration project. Students also examined upland sites by analyzing soil cores, and discussing climate data and carbon flux measurements at an atmospheric flux tower near the top of the watershed. A drive to the Grand Tetons allowed students to gain insights into the geologic and evolutionary processes that operate over larger temporal and spatial scales. The course provides incoming students with an appreciation for the necessity of understanding the impact of scale on system processes. The success of this new course is in part demonstrated by the formation of an informal journal club that emerged from this cohort of new graduate students this past fall. Ecological restoration is the theme for group readings and discussions this fall. We hope to formalize this activity by offering this journal club as a course for credit beginning next year.

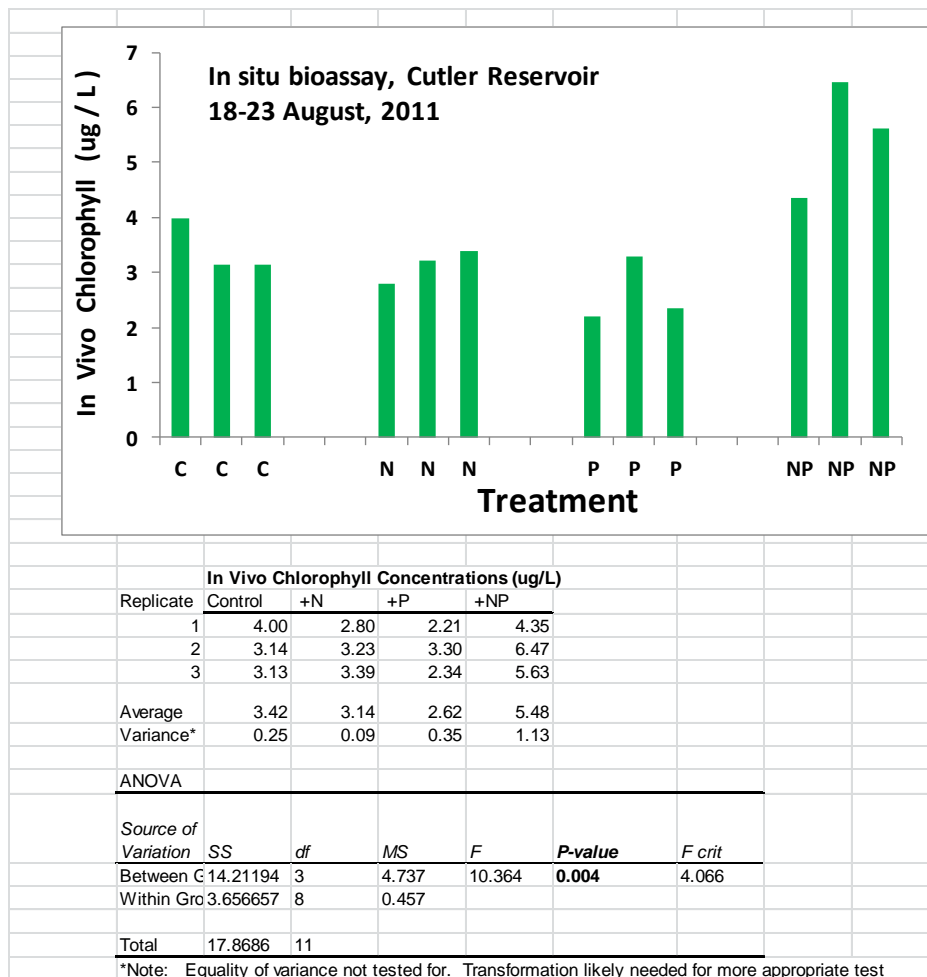


Figure 4. Short-term bioassay experiment of nutrient limitation in Cutler Reservoir. Students learned about co-limitation of nutrients for phytoplankton production, were exposed to the value of replication in experimental design, and conducted statistical tests of the results of the experiment.

The Geomorphology and Earth Surface Processes specialization is a joint offering between WATS and the Department of Geology. A number of faculty in both programs with interests in geomorphic change suggested this new inter-departmental program. We are enthused about the efforts of faculty in both

departments to collaborate on this research focus and plan for graduate students in this specialization to benefit from a broader approach to studies in watershed sciences.

In spring of 2011 Watershed Sciences received the Department Teaching Excellence Award for efforts and accomplishments in our undergraduate and graduate educational programs. In a written citation, the department was praised for “never (wavering) in its commitment to make students aware of human impacts in the natural world and our responsibility for stewardship of the planet’s environment and its precious natural resources.” Our department was the tenth out of 49 departments on campus to receive this award.

SUPPORT FUNCTIONS OF THE COLLEGE OF NATURAL RESOURCES

The success of the degree programs in Watershed Sciences depends in large part on the ability of our faculty and students to use resources from the Quinney Library and from individual faculty laboratories. The Quinney Library hosts two computer service labs with 52 stations equipped with PC and Mac platforms with the latest ESRI, ERDAS, and SAS software. These teaching laboratories are essential for the delivery of our courses in GIS, remote sensing, statistics, modeling, and data analyses. These CNR teaching laboratories provide us the opportunity to place course-specific software on the machines and to allow students the opportunities to place their work on CNR-hosted servers.

Our academic programs involved laboratory and field-based training of students. In order for students to gain experience using the latest techniques in aquatic and environmental sciences, we use a variety of research equipment that is housed and maintained by research labs in the department. Departmental operating funds and student course fees are used to some extent to maintain this equipment, but it is largely the generosity of the faculty that allows our teaching program to thrive.

OUTREACH PROGRAMS

Extension and outreach programs in the Department of Watershed Sciences are conducted informally by many faculty, but the major portion of these activities fall within the domain of the USU Water Quality Extension Program directed by Nancy Mesner, and the Master Naturalists Educational Program directed by Mark Larese-Casanova.

Water Quality Extension Program

The mission of the Water Quality Program is to help people understand the link between their everyday activities and land uses and the quality of our water. This program provides a wealth of information to help the public protect the quality of Utah’s streams and rivers, lakes and reservoirs, and groundwater. The director, two full-time water quality staff, two graduate students, and three part-time assistants staff the program through activities and projects aimed at watershed managers, K-12 students, K-12 teachers, and citizen scientists. Nancy and her staff work closely with the Utah Division of Water Quality, the Utah Watershed Coordinating Council, and other state and federal agencies to identify needs and develop materials and programming that assist watershed managers throughout the state and region. Her program also works closely with the Utah Office of Education to develop and deliver hands-on water quality and watershed lesson plans and curricula, all tied to the Utah core and national environmental education standards. Some of their current projects include:

- The implementation and assessment of an interactive watershed outreach program at Swaner EcoCenter that incorporates real time data from a nearby monitoring station, and involvement of youth in data collection and interpretation.
- Assessment of Utah's 319 nonpoint source program, including both a process review and an evaluation of the effectiveness of implemented water quality projects.
- The effectiveness of short term field day activities in increasing student knowledge and eliciting changes in attitudes about protecting water quality.
- Development and implementation of a statewide citizen monitoring program, which the goals of increasing citizen awareness of watershed protection and collect credible data to fill identified data gaps;
- Development, assessment and delivery of hands-on water quality and aquatic biology activities and lessons for K-12 and training for educators in the use of these activities;
- Direct assistance and training for state watershed coordinators on outreach activities and on monitoring for bmp impact assessment;
- Coordinated water quality programming throughout EPA's region 8 and Western Advisor for a recently funded NIFA national water outreach program (Water Equals).

Recent publications include

- Mesner, Nancy and Ginger Paige. 2011. Best Management Practices Monitoring Guide for Stream Systems. University of Wyoming B-213.
- Spackman Jones, A., N. O. Mesner, J. S. Horsburgh, R. J. Ryel, D. K. Stevens (2011), Impact of sampling frequency on annual load estimation of total phosphorus and total suspended solids, *Journal of Hydrology*, (In Review).
- Improving Utah's Water Quality factsheets (2011) for Scofield Reservoir watershed; San Rafael River watershed; Price River watershed and Middle Bear River.

Additional information on the Water Quality Extension Program can be found at:

<http://extension.usu.edu/waterquality/>

The Utah Master Naturalist Program

The mission of the Utah Master Naturalist Program is to provide continuing educational experiences in Utah's diverse ecosystems to its citizens. Mark Larese-Casanova directs the program and has developed week-long modules in Utah Watersheds, Utah Deserts, and Utah Mountains. Each module consists of 40 hours of instruction which is delivered in a mix of classroom and field experiences. The program is targeted to professional environmental educators, K-12 teachers in the public schools, and volunteer naturalists.

Mark employs six assistants who have been trained to deliver the courses. A total of 79 people completed at least one the UMNP modules during the past two years. The pool of participants was 76% female and 24% male, with an average age of 46 (range=22-72). In general, the participants were well educated, with 84% having at least a Bachelor's Degree. In addition, 18% and 2% had Master's and Doctorate Degrees, respectively. Seventeen participants, upon completing the Mountains module, became Certified Utah Master Naturalists in all three UMNP modules this year. One Watersheds class was sponsored by the Utah State Office of Education, and was taught exclusively to twelve K-12 teachers.

RESEARCH CENTERS AND UNITS

The Department of Watershed Sciences supports several research centers and participates in joint research collaborations with other units across campus. These centers and units assist in collaboration among faculty, provide a platform for the exchange of ideas, and support graduate student research. A summary of the activities of these units follows.

BLM/USU National Aquatic Monitoring Center



The National Aquatic Monitoring Center (NAMC) is a cooperative venture between Utah State University and the U.S. Bureau of Land Management. The purpose of the Center is to encourage and foster scientifically sound watershed monitoring programs on public lands. NAMC's goals are to increase the consistency and quality of aquatic resource assessments and provide clear, accurate, and timely information to resource managers and the public. A primary focus at the laboratory is the processing of aquatic invertebrate samples from across the United States. The identification and enumeration of these samples then contributes to the national database of aquatic invertebrates and the development of regional predictive models of biological condition. Annually the lab runs 1700 samples from a variety of agencies, states, and environmental organizations.

In addition to operating the service laboratory for invertebrate sample processing, the Center conducts specific research projects related to the use of aquatic invertebrates to assess environmental quality. One of these projects currently being conducted is an assessment of the status of the Green River near Flaming Gorge Dam. This cooperative project among the Center, the Utah Division of Wildlife Resources, and the Bureau of Reclamation evaluates the effects of Flaming Gorge Dam on the downstream aquatic ecosystem of the Green River. Since 1993 the NAMC has collected data on aquatic invertebrates, aquatic plants, and trout diets, and summarized more than 100 years of hydrologic and more than 50 years of aquatic invertebrate data in this reach of the Green River. This project provides a good example of the value of long-term monitoring in that decadal-scale changes in the river food web have been apparent in response to flow and thermal alterations. Documentation of these changes has assisted managers in their efforts to preserve native biodiversity in this highly altered river system.



Western Center for Monitoring and Assessment of Freshwater Ecosystems



The primary mission of the Western Center for Monitoring and Assessment of Freshwater Ecosystems is to facilitate the development and application of scientifically sound methods for monitoring and assessing the condition of aquatic ecosystems. The Center is housed within the College of Natural Resources at Utah State University and staffed by faculty, technicians and students from the Departments of Watershed Sciences and Computer Science. Center partners and collaborators include the United States Environmental Protection Agency, the United States Bureau of Land Management, the United States Forest Service, and the United States Geological Survey. The Center works closely with the BLM/USU National Aquatic Monitoring Center, which conducts taxonomic identification of

macroinvertebrate specimens from field samples and provides technical expertise regarding aquatic monitoring to BLM Field Offices and other federal agencies.

The Center provides three web-based resources to the ecological assessment community. The Bioassessment module provides a brief review of the ecological assessment literature as applied to freshwater ecosystems. The Predictive Models module describes the theory and application of predictive models as used in ecological assessments (Primer) as well as a summary of how to use existing models build custom models (Using and Building Models). The third component of this module (Predictive Models Software) provides a link to our web-based software that runs predictive models and generates both O/E and Bray-Curtis indices that quantify biotic condition at assessed sites. The Data module provides access to a query tool that allows users to download biological and environmental data associated with thousands of study locations that have been entered into our database. The database includes samples processed by the BML/USU Buglab, NAWQA stream reference site data, data used in the National Wadeable Streams Assessment, PACFISH/INFISH (PIBO) data, and various State data.



Some Current or Recent Projects include:

- Development of bioassessment tools for Utah, Wyoming, Idaho, Colorado, and Montana (funded by U. S. Environmental Protection Agency, Regions 8 and 10)

We are aiding state agency scientists and managers to develop and/or refine methods for assessing the biological condition of streams and rivers in several western States. This work involves assessment of data comparability, selection of reference sites if needed, development of predictive models, and comparisons of predictive model assessments with those based on other methods.

- Testing watershed classifications relevant to bioassessment, conservation planning, and watershed restoration (Funded by USEPA, Science to Achieve Results (STAR))

This major research project is designed to determine which types of watershed classification systems are most effective in detecting biological impairment (bioassessment), assessing conservation value of stream ecosystems, and prioritizing streams for restoration. A main objective of the project is to test the hypothesis that it is possible to distinguish biological degradation associated with changes in nutrients, habitat, hydrology, and temperature from one another by comparing the specific biota observed at a disturbed site to the responses biota are expected to exhibit to alteration in each of these four major environmental factors.

Intermountain Center for River Rehabilitation and Restoration

The mission of the Intermountain Center for River Restoration and Rehabilitation (ICRRR) is to advance the science and practice of river restoration and environmental management and to transfer that knowledge to the public and private sectors. ICRRR conducts its work through completion of targeted research projects, providing decision support to federal agencies and adaptive management programs, evaluating the performance of previously constructed restoration



projects, and teaching short courses about stream restoration methodology to practitioners. ICRRR's regional focus is the streams and rivers of the Intermountain West. These riverine systems are critical ecosystem resources that support valued native and sport fisheries, while also supporting water supply and power production uses by society. Our goal is to promote the scientific management, rehabilitation, and restoration of these valuable ecosystems.

USGS Utah Fisheries and Wildlife Cooperative Research Unit

The Intermountain West is undergoing dynamic demographic changes accompanied by changing land uses, and increasingly diverse and often conflicting demands on limited natural resources. As a result, finding solutions to complex natural resource problems has necessitated an increasingly inter-disciplinary approach. A



Cooperative Agreement signed between the US Department of Interior and Utah State University in 1935 established the existence, mission, and function of the Utah Cooperative Fish and Wildlife Research Unit. It provides an organizational mechanism that enables the Unit, in the setting of the

College of Natural Resources, to create and facilitate cooperative, interdisciplinary relationships between Faculty in all departments of the College and across Utah State University, with the Utah Division of Wildlife Resources, the Wildlife Management Institute, and the USGS Biological Resources Division. Further, the Research Work Order Process, unique to the Cooperative Research Unit Program, allows cooperative interaction between faculty at Utah State University and any federal agency. Specifically, it is the mechanism that allows acceptance of federal research funds non-competitively.



The mission of the Utah Unit, as stated in our Cooperative Agreement, is to conduct research on natural resource issues, educate students destined to work in the field of natural resources, and provide technical assistance to our cooperators and clientele. Our expertise includes landscape and spatial ecology, population and system analysis for both aquatic and terrestrial systems, aquatic food webs of large water systems, and wildlife habitat and vegetation modeling. Technical expertise in the fields of statistics, GIS and spatial analysis is strong.

We view our role as colleagues and partners who can bring our agency connections, as well as the administrative and material resources of the Unit to help our faculty colleagues in a meaningful way. The Unit vision is to accomplish our mission to the best of our abilities. We do this by establishing a Unit program whose culture and operating principles are based on win-win interactions that enable, invigorate, and empower all parties. We accomplish our vision with partners who are as committed to the same values.

USFS Fish and Aquatic Ecology Research Unit

The mission of the Forest Service Fish and Aquatic Ecology Unit is to identify emerging aquatic resource issues, develop technology to help address these issues, and transfer this technology to field biologists. The Fish and Aquatic Ecology



Unit provides scientifically sound, cost-effective technologies to aquatic resource specialists in support of the conservation and restoration of aquatic communities on Forest Service land.

The Fish and Aquatic Ecology Unit works with federal and state research organizations and universities to develop technology to address emerging resource issues. Once this technology is developed we disseminate this technology to aquatic resource specialists through, continuing education workshops, presentations, publications, and on-site visits. Much of our recent research has focused on developing scientifically sound methods to measure in-stream and riparian habitat in western US watersheds.

Water Initiative

Academic departments in six colleges contribute to water research, education, and extension at Utah State. Each department grants its own degrees and has its own acceptance and graduation requirements. The Utah State Water Initiative works to facilitate collaborative research and to foster a collegial interdisciplinary community of water scholars.



Utah State University supports a broad community of Students and Faculty engaged in Water Education, Research and Outreach. The USU Water Initiative provides an overarching umbrella for the activities of this community aimed at fostering interdisciplinary collaboration and collegial sharing of ideas related to water across the departments and colleges of Utah State University. USU Water Initiative seminars, as well as water related seminars in a number of colleges and departments occur on a regular basis. The Spring Runoff Conference, so named because it is held at the end of winter and in anticipation of spring's runoff season – a time of anticipation and excitement in hydrology, provides another opportunity for the sharing of ideas and scholarly debate.

A major goal of the Utah State University Water Initiative is the establishment of a Laboratory Watershed. The Great Salt Lake Basin and within it the Bear River Watershed serve as a microcosms for many water resource, science, and policy issues in the western U.S. Climate variability, effects of drought, water quality, urban and agricultural development, and interstate policies are all important concerns. Our efforts to establish a laboratory watershed are ongoing and include information found at the Bear River Watershed Information Systems at: <http://www.bearriverinfo.org/>

FACULTY

At the beginning of the 2011-12 academic year, Watershed Sciences had 8.03 Education and General (E&G) funded faculty lines. These include the following individuals with faculty ranks and date of initial appointment as indicated. A number of faculty in the WATS department have split appointments with other academic or research units on campus. Three additional faculty are federal cooperators. Inclusion of these faculty brings our faculty headcount to 14 individuals. (Table 6)

Table 6. Watershed Sciences Faculty. The number of full time equivalent faculty lines funded through the Education & General (E&G FTEs) is shown. Several faculty members have split appointments. CNR is the College of Natural Resources, WILD is the Department of Wildland Resources, PSC is the Department of Plant, Soils, and Climate, and AES is the Utah Agricultural Experiment Station.

Watershed Sciences Faculty

Full professors	E&G FTEs	Appointment in other units	Joined USU
Wayne Wurtsbaugh	1.0		7/1983
Charles Hawkins	1.0		9/1983
Chris Luecke	0	(CNR Interim Dean)	11/1988
Todd Crowl	1.0		3/1990
John (Jack) Schmidt	1.0		9/1991
Helga Van Miegroet	0.23	(WILD and AES)	1/1993
Associate Professors			
Nancy Mesner	0.1	(CNR and USU-Extension)	8/1998
Assistant Professors			
Jiming Jin	0.4	(PSC and AES)	1/2008
Karin Kettenring	0.9	(AES)	8/2008
Joseph Wheaton	1.0		7/2009
Patrick Belmont	0.4	(AES)	12/2009
Sarah Null	1.0		8/2011
Extension Educator			
Mark Larese-Casanova	0	USU Extension	12/2003
Federal Cooperators			
Phaedra Budy		USGS-Fisheries & Wildlife Research Unit	11/1996
Brett Roper		USFS Fish & Aquatic Ecology Research Unit	7/2003
Scott Miller		US-BLM National Aquatic Monitoring Center	10/2009

Helga Van Miegroet and Jiming Jin have appointments in other academic units (Wildland Resources and Plant, Soils & Climate, respectively). Van Miegroet, Jin, Karin Kettenring, and Patrick Belmont have appointments with the Utah Agricultural Experiment Station in our College of Agriculture. Nancy Mesner has appointments through USU Extension and an administrative appointment as Associate Dean of our College of Natural Resources. As Interim Dean, Chris Luecke’s appointment is through the CNR Dean’s office. During the past six years, our E&G faculty lines have increased by one when we added Karin Kettenring’s line. In addition to state supported faculty lines, we also have a number of federal cooperators serving faculty roles in the department (Budy, Roper, Miller). These faculty maintain vigorous research programs involving a number of graduate students. Their teaching loads are approximately half the loads of state-supported faculty, and include key courses in our undergraduate (Fish Diversity, Fisheries Management, Freshwater Invertebrates) and graduate (Fish Ecology, Fisheries Analysis using “R”) academic programs.

Profiles of these faculty members follow along with information on their educational backgrounds, current research interests, and the courses they teach. Full CVs are located in Appendix 6. A summary of faculty profiles follow this section. Of the 14 faculty members on campus, five are women, and one is a Chinese citizen.

The Department has a number of adjunct faculty (Table 7). These faculty perform a variety of functions but primarily assist us in the delivery of courses and as members of graduate committees. The adjunct members who are faculty in other USU departments have significant research projects with faculty members in WATS. These faculty serve on graduate committees and occasionally supervise graduate students in our department degree programs.

Table 7. List of adjunct faculty members, their home institutions or departments and the major contribution they make to the departmental mission and goals.

Name	Institution	Contribution
Nicholas Allmendinger	Otak Inc., Senior Geomorphologist	Instructor
Matthew Baker	University of Maryland, Baltimore County	Serve on graduate committees
Michelle Baker	Utah State University, Biology Department	Serve on graduate committees
Nicolaas Bouwes	Eco Logical Research Inc., Owner	Serve on graduate committees
Joanna Endter-Wada	Utah State University, Environment and Society Department	Collaborate with faculty research
Robert Gillies	Utah State University, Plant, Soils, and Climate Department	Serve on graduate committees
Emily Holt	Utah Valley University	Instructor
Tamao Kasahara		Serve on graduate committees
Danielle Larson	Swaner EcoCenter, Land Management Specialist	Collaborate with faculty research
David Naftz	USGS Water Science Center	Collaborate with faculty research
Christopher Neale	Utah State University, Depart. of Civil and Environmental Engineering	Serve on graduate committees
Joel Pederson	Utah State University, Dept. of Geology	Serve on graduate committees
Michael Scott	USGS Science Center, Fort Collins, Colorado	Instructor and Serve on graduate committees
Jennifer Shah	Riparian Ecologist	Brendan McCulley Committee
David Tarboton	Utah State University, Dept. of Civil and Environmental Engineering	Serve on graduate committees
Mark Vinson	USGS Great Lakes Science Center, Wisconsin	Serve on graduate committees
Michael White	Nature, Climate Science Editor	Serve on graduate committees
Peter Wilcock	Johns Hopkins University, Geography Department	Instructor
James Wilson	Utah Division of Wildlife Resources	Instructor

Faculty Research Interests, Productivity, and Impacts

Faculty in the Department of Watershed Sciences publish in highly ranked peer-reviewed journals. The fifteen faculty listed in Table 6 published 31 peer-reviewed papers in 2011 (Web of Science search). During the past six years these faculty have published 180 papers, an average of 2.3 publications per faculty per year (Figure 8). Citations to faculty publication exceeded 900 in 2011, indicating the value of our research publications to the scientific community.

Faculty in the Department of Watershed Sciences excel at obtaining research funding from external sources. The figure below (Figure 5) shows the dollar value of external grants awarded to WATS faculty members during the past 6 years. Many of these grants extend over several years, so a longer time period provides a better sense of our annual research funding. The dollar value of our annual research grants awarded to faculty varies considerably from year to year, but has averaged more than \$3M since 2005. These values are impressive given that the budget for salaries and operating costs for the department is less than \$1M annually.

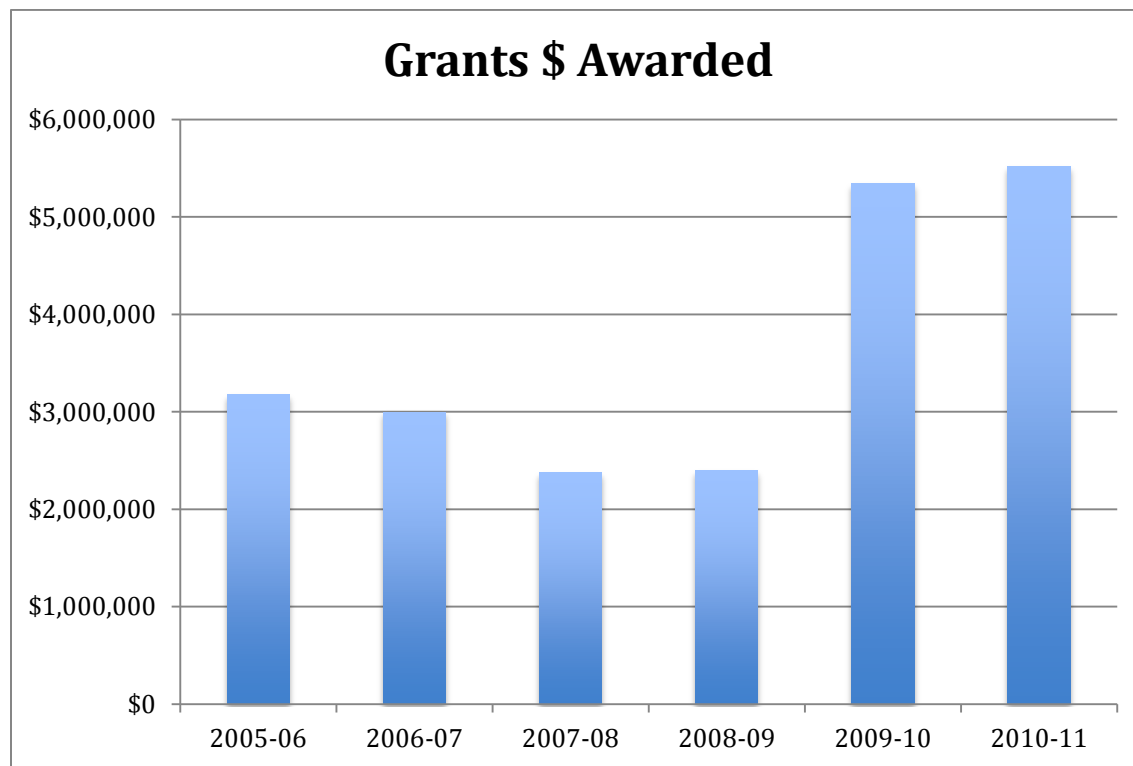


Figure 5. External grants awarded to Watershed Sciences faculty from 2005 through 2011.

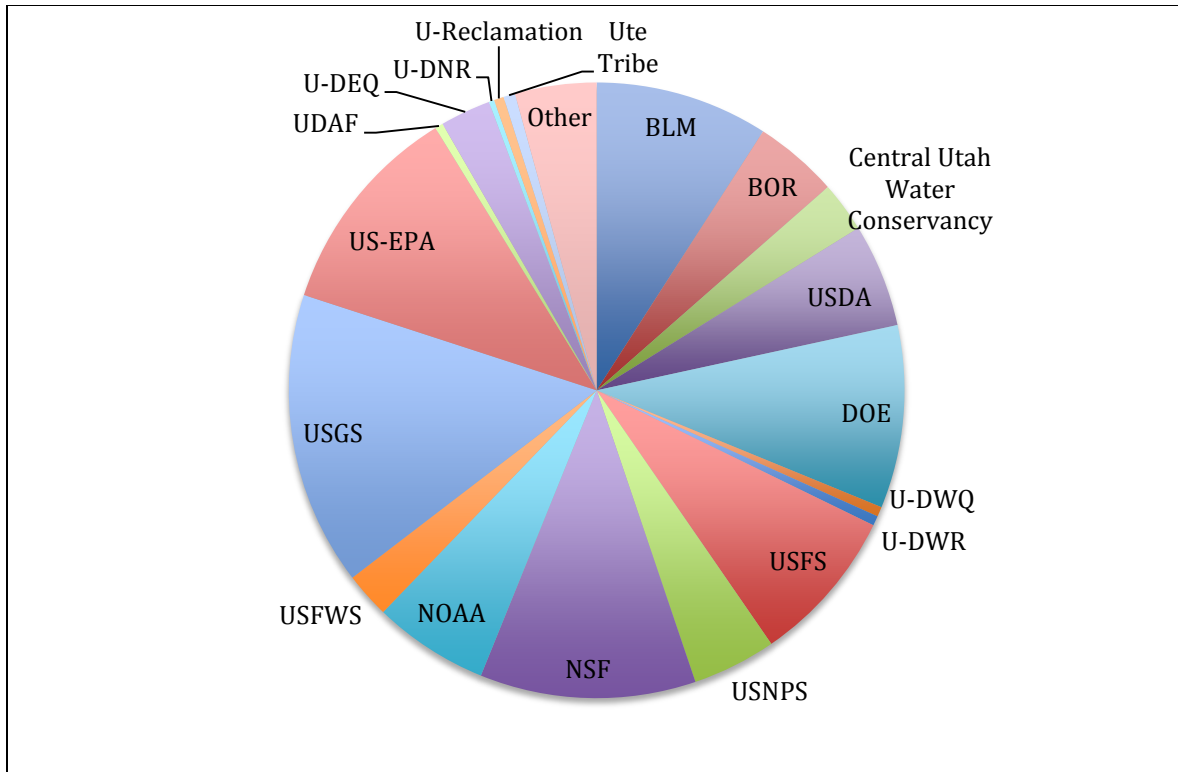


Figure 6. Relative composition of grant funding for the 2010-2011 academic year.

Research programs directed by faculty in the Watershed Sciences faculty are funded by a diverse suite of agencies and foundations. The previous figure (Figure 6) shows the relative composition of grant funding for the 2010-2011 academic year. The total grant dollars from external sources exceeded \$5.3 in 2010-2011. Additional funds from USU internal sources provided an addition \$150,000 dollars. The amount of funding received by individual faculty members varies considerably both among faculty and among years. Typically the senior faculty have larger research budgets as more junior faculty are working to build networks of scientific and agency collaborators to pursue their research interests. Some of our federal cooperators (Budy and Miller) have access to non-competitive funds from their agencies. During the past three years, Dr. Jack Schmidt has been the recipient of a federal earmark from the Department of Energy to develop and implement programs within the Intermountain Center for River Restoration and Rehabilitation. The graph on the next page (Figure 7) shows research funding received by individual faculty members during the 2010-11 academic year.

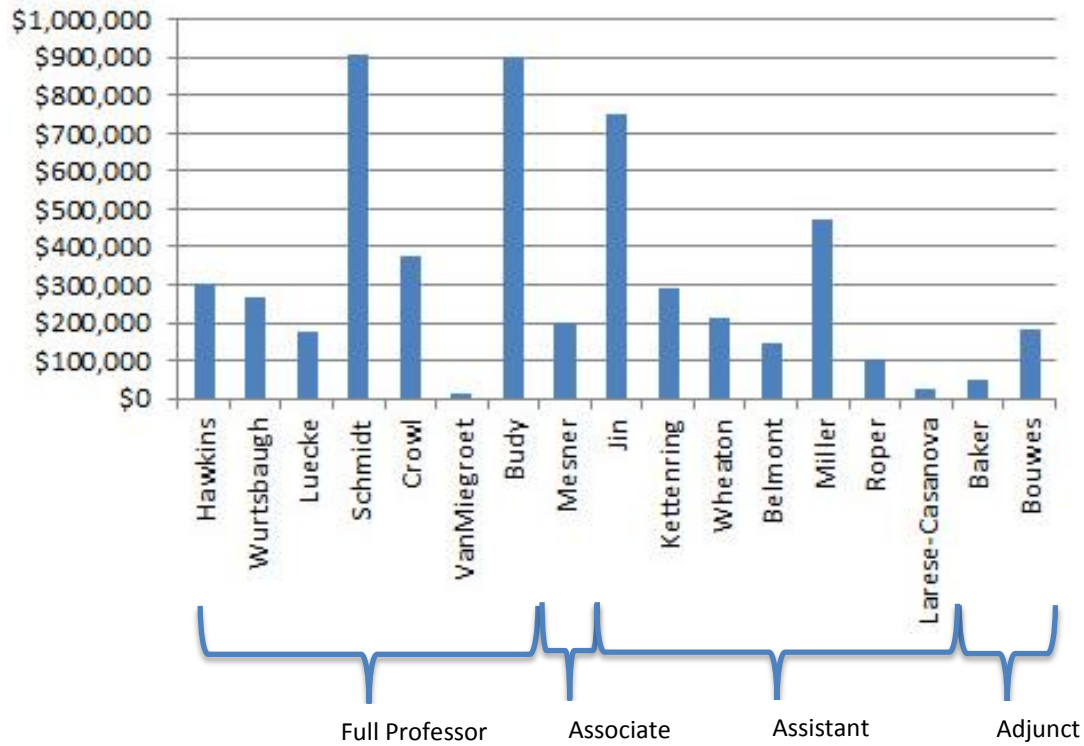


Figure 7. Research funding received by individual faculty members during the 2010-2011 academic year.

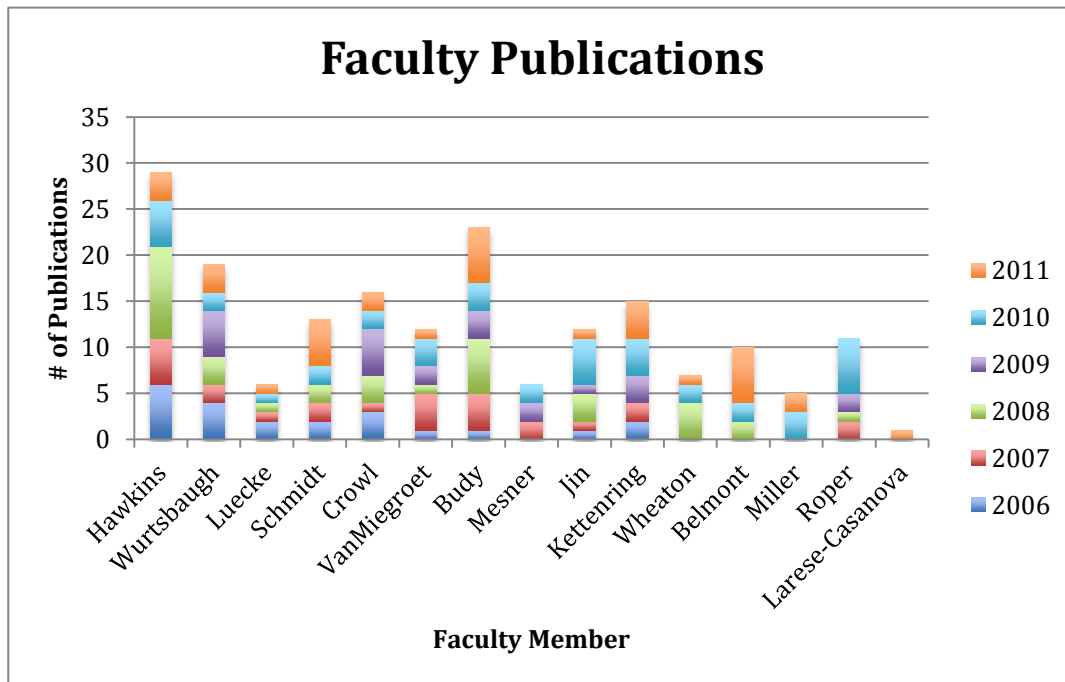


Figure 8. Number of Faculty Publications from 2006 to 2011

Faculty Pages

Dr. Charles Hawkins, Professor and Interim Department Head

Research Interests - Stream Ecology, Aquatic Biodiversity, Ecological Assessment

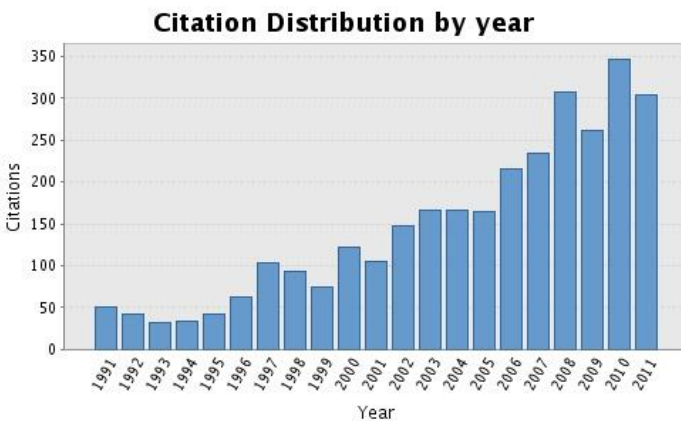
Teaching Role – Stream Ecology WATS 6820, Communicating Science WATS 6400

Chuck Hawkins is Director of the Western Center for Monitoring and Assessment of Freshwater Ecosystems. The primary mission of this Center is to facilitate the development and implementation of scientifically sound methods for monitoring and assessing the condition of aquatic resources in the western United States. Chuck is presently involved in a variety of research projects examining how patterns of biodiversity are affected by anthropogenic factors. One recent focus is a project examining *Consequences of Global Climate Change for Stream Biodiversity*. This project is funded by the US Environmental Protection Agency (with Drs. Jiming Jin and David Tarboton). The main objective of this project is to assess how changes in stream temperature and hydrology associated with global/regional climate change will influence the biodiversity and functioning of stream ecosystems. Biological indicators are used to determine if streams are meeting the biological water quality goals of the Clean Water Act. For this project, we are downscaling coarse resolution (~200 km) global climate model simulations and forecasts to fine resolution data (~4 km) for the entire United States. These downscaled high-resolution climate data will be useful in improving our understanding of climate and ecosystem changes over the Intermountain West.



Dr. Hawkins teaches a 3-credit graduate course in Stream Ecology each fall. In spring he teaches a 1-credit course titled Communicating Science to first year graduate students. Students in this class prepare a pre-project proposal for their research committees, and present the results of this proposal to the department at the annual Graduate Student Symposium.

Citations to Chuck Hawkins research publications are presented below. Chuck is our most prolific author of scientific papers. His research is highly valued by the large number of citations to his published work and his h-index of 30 (30 published papers with at least 30 citations each).



Total peer-reviewed articles: 69
Total number of citations: 3287
Average citations per article: 49
h-index: 30

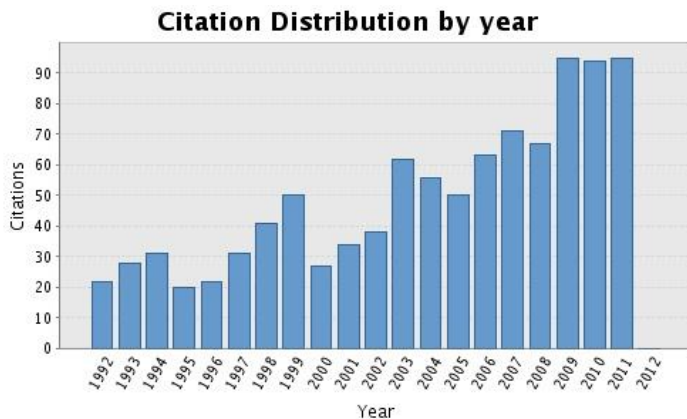
Dr. Wayne Wurtsbaugh, Professor

Research interests - Limnology and Fish Ecology
Teaching Role - Limnology WATS 4500/6500, Aquatic Ecology
Practicum WATS 4510

Wayne's current research is focused on two different aquatic ecosystems. In the Sawtooth Mountains of Idaho he has been working with Michelle Baker from the Biology Department and Brian McGlynn of Montana State University to study how nutrients (similar to fertilizer) move through watersheds that have series of streams and lakes. This will help predict how much growth of algae, invertebrates and fish one might expect in a system, and to understand how pollution might influence these systems. In the Great Salt Lake Dr. Wurtsbaugh and his students have also been studying how excessive nutrient discharge from sewage treatment plants is influencing the plants and animals. Some of the microscopic plants (algae) that proliferate under these conditions produce toxins that might harm birds and humans that swim in the water. They are also studying how the high levels of mercury and selenium and other heavy metals in the lake move through stromatolite food webs and into the birds that feed on the organisms produced by the lake. Understanding these processes should lead to ways to reduce contamination in the lake and protect the shorebirds and ducks that utilize the lake.



Dr. Wurtsbaugh teaches Limnology every spring semester (3 credits) and the Aquatic Ecology Practicum course each fall (3 credits). The limnology class is offered to distance education students through broadcast media, and contributes to the MNR core course offerings.



Total peer-reviewed articles: 75
Total number of citations: 1178
Average citations per article: 19.31
h-index: 20

Dr. John (Jack) Schmidt, Professor

Research interests - Stream Geomorphology and Restoration

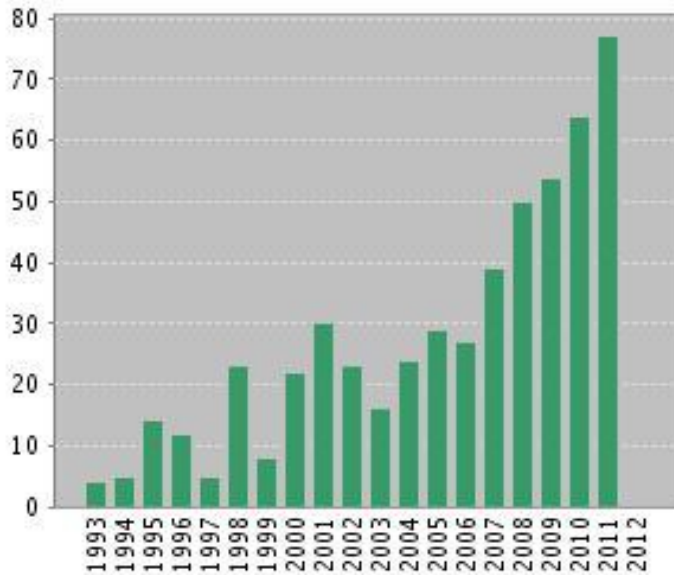
Teaching Role – Fluvial Geomorphology WATS 5150, Fluvial Geomorphology Laboratory WATS 5170, Watershed and Stream Restoration WATS 5660

The bulk of Dr. Schmidt’s professional career has focused on fluvial geomorphology, especially as applied to the science and management of large regulated rivers. He has worked on numerous river science and management issues in Grand Canyon for more than 25 years, and has worked on similar issues on the Rio Grande, rivers of the upper Colorado River watershed, and Columbia River system. The impact of this body of work was recognized by the National Park Service who awarded him their 2009 Director’s Award for Natural Resources Research. In 1997, he was a co-recipient of the U. S. Geological Survey’s Shoemaker Communications Award “for excellence in communicating scientific information” for Circular 1126, Dams and Rivers: Primer on the Downstream Effects of Dams. He presently helps lead an emerging science program focused on rehabilitating the Rio Grande on the U. S. – Mexico border. Presently, he is on leave from the university and serves as Chief of the U. S. Geological Survey’s Grand Canyon Monitoring and Research Center.



Jack Schmidt teaches the Fluvial Geomorphology lecture (3 credits) and laboratory course (2 credits) every fall semester. He also teaches the Watershed and Stream Restoration course (2 credits) each year.

Citation Distribution by year



Total peer-reviewed articles: 35
Total number of citations: 529
Average citations per article: 15
h-index: 14

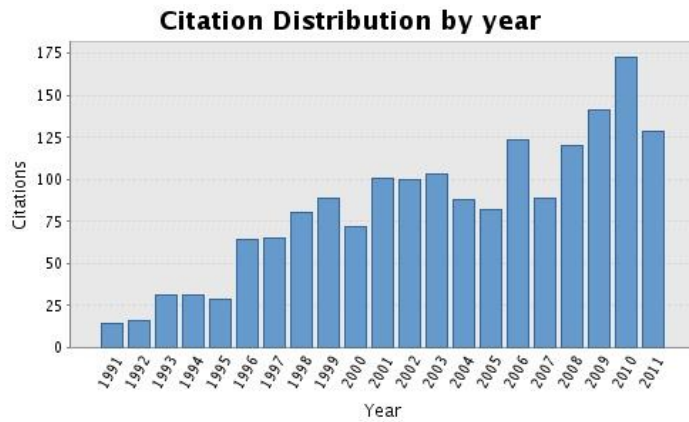
Dr. Todd Crowl, Professor

Research interests - Biometry, Conservation Biology, Biodiversity
Teaching Role – General Ecology NR 2220, Aquatic Production Biology WATS 6120

Much of Todd’s current research is focused on a biocomplexity project at the Luquillo Experimental Forest as part of the NSF-LTER program in Puerto Rico. The goal of the Luquillo Long-Term Ecological Research Program (Luquillo LTER) is to understand how changing climate and land use are affecting the environment of northeastern Puerto Rico. Luquillo LTER includes both terrestrial and aquatic studies, from the peaks of the Luquillo Mountains to the city of San Juan, encompassing strong gradients of both climate and land use. The goals of the biocomplexity project are to develop and test the analytical tools needed to understand and predict the interactions and feedbacks among humans and aquatic species across complex landscapes. Our central organizing principle is that landscape patterns and changes in network structure and function are explained by energy and time optimizations of water flows, biota and humans. Although we understand many ways that each subsystem individually optimizes time and/or energy, each optimization imposes constraints on related subsystems, which can then change the rules by which each operates. These multiple feedbacks and resulting emergent properties are hallmarks of a complex adaptive system that can be simulated using an individual- (agent) based simulation model.



Todd Crowl teaches the General Ecology course (3 credits) each fall. This course is required for most undergraduate degrees in CNR and for the BS in Biology. He teaches the Aquatic Production course (2 credits) in spring and teaches graduate seminar classes.



Total peer-reviewed articles: 45
Total number of citations: 1748
Average citations per article: 39
h-index: 24

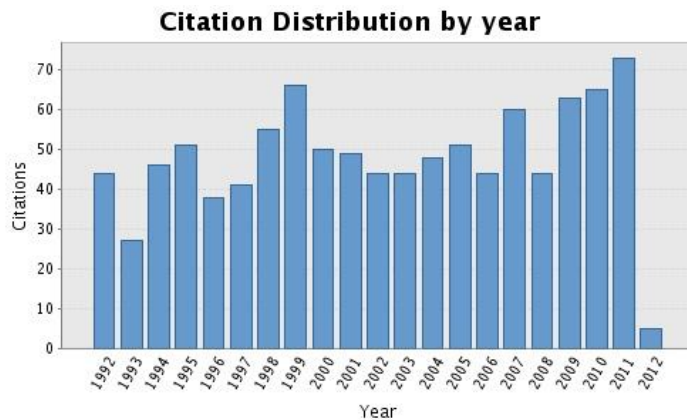
Dr. Helga Van Miegroet, Professor

Research Interests - Wildland Soils and Biogeochemistry
Teaching Role -

Helga's research focuses on the soil processes, nutrient cycling transport mechanisms in wildland ecosystems; pollution effects on soil-plant interactions and freshwater quality; and effects of management, vegetation change and climate change on carbon storage and stability in wildland soils. Her research on forest soils in the intermountain west and Europe investigates interaction between vegetation, soils and climate on stabilization of carbon within the soil, which represents the largest carbon pool in terrestrial ecosystems with large potential impacts on the global carbon balance. Soil organic carbon is also pivotal to many functions that contribute to healthy ecosystems and site productivity. Her research addresses basic research questions, such as the mechanisms of soil carbon stabilization and its controlling factors. It also has practical application to the landusers, including the impacts of land use changes or management practices on site conditions and potential restoration efforts. Dr. Van Miegroet has collaborated with European colleagues to account for effects of land use and climate change and the resultant vegetation shifts and soil carbon storage the intergovernmental European Cooperation in Science and Technology or 'COST' framework, to improve reporting and measurement tools to comply the Kyoto Protocol. She is also collaborating with colleagues at USU and in Europe on the use of novel spectroscopic techniques to identify vegetation sources of soil organic carbon and the relationship between carbon compound chemistry and pathways of stabilization in the mineral soil.



Dr. Van Miegroet teaches the Fundamentals of Watershed Sciences class every other spring (3 credits). She also teaches Soil Science (3 credits) and Terrestrial Biogeochemistry (3 credits) every other year.



Total peer-reviewed articles: 37
Total number of citations: 1132
Average citations per article: 30.59
h-index: 20

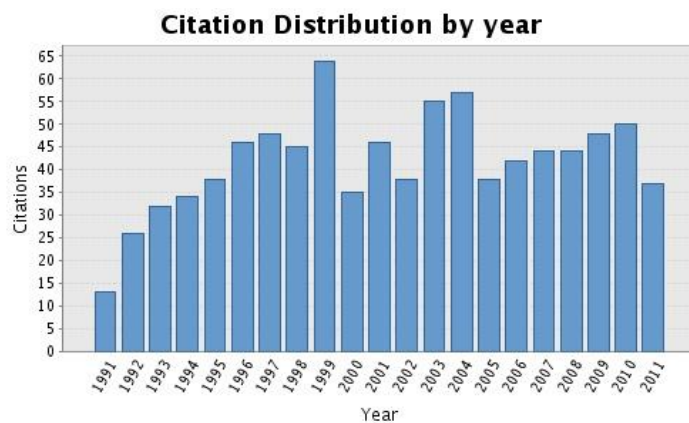
Dr. Chris Luecke, Professor and Interim Dean of the College of Natural Resources

Research interests - Aquatic Ecology and Fisheries Management
Teaching Role – Watershed Science Professional Orientation WATS 1020

Chris maintains his research on aquatic ecosystems in the Arctic. As this region warms, the habitat for fish living in small lakes and streams is being reduced considerably. On the north slope of the Brooks Range in northern Alaska, arctic grayling evolved in waters that rarely exceeded 20°C. During the past decade, the surface waters of many lakes and streams routinely reached this degree of warming. In the three warmest years of the decade (2004, 2007, 2009), grayling living in lakes lost weight in summer months. During cooler summers, grayling grow substantially during the summer months to store energy for the long dark winter when food resources are scarce. Chris Luecke and his graduate students have documented that the small shallow ponds that historically were used by grayling for summer feeding habitat became too warm to support fish growth rates in these hot summer periods. Lower levels of rainfall also accompany these warmer summers. This reduction in rain reduces water in streams and restricts the ability of fish to find the best feeding habitats by reducing movement among the lakes.



Dr. Luecke teaches the Watershed Sciences Professional Orientation course (1 credit) each fall. This class introduces our incoming undergraduate courses to the field and provides some career guidance.



Total peer-reviewed articles: 41
Total number of citations: 987
Average citations per article: 24.07
h-index: 18

Dr. Phaedra Budy, Professor

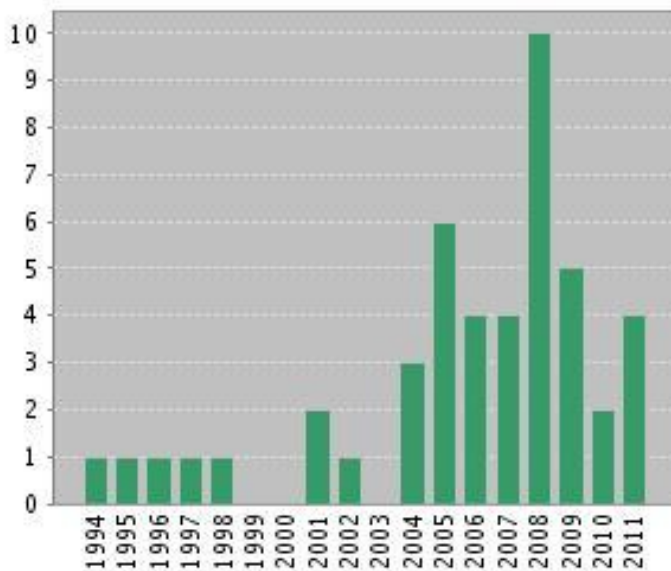
Research interests - Aquatic Ecology, Conservation Biology
Teaching role – Diversity of Fishes (WATS 3100) and Fish Diversity Laboratory (1 Credit)



Phaedra is assistant leader of the Utah Cooperative Fish and Wildlife Research Unit. In this role she conducts research on the aquatic resources of the western US and provides guidance to state and federal fish and game agencies in their efforts to manage native and sport fish populations. The Intermountain West is undergoing dynamic demographic changes accompanied by changing land uses, and increasingly diverse and often conflicting demands on limited natural resources. As a result, finding solutions to complex natural resource problems has necessitated an increasingly inter-disciplinary approach. A Cooperative Agreement signed between the US Department of Interior and Utah State University in 1935 established the existence, mission, and function of the Utah Cooperative Fish and Wildlife Research Unit. It provides an organizational mechanism that enables the Unit, in the setting of the College of Natural Resources, to create and facilitate cooperative, interdisciplinary relationships between Faculty in all departments of the College and across Utah State University, with the Utah Division of Wildlife Resources, the Wildlife Management Institute, and the USGS Biological Resources Division. Further, the Research Work Order Process, unique to the Cooperative Research Unit Program, allows cooperative interaction between faculty at Utah State University and any federal agency. Specifically, it is the mechanism that allows acceptance of federal research funds non-competitively.

Dr. Budy teaches the Diversity of Fishes class (3 credits) and associated laboratory course (1 credit) each fall semester.

Citation Distribution by year



Total peer-reviewed articles: 46
Total number of citations: 348
Average citations per article: 7.6
h-index: 11

Nancy Mesner, MSE, Associate Professor, Associate Dean of the College of Natural Resources

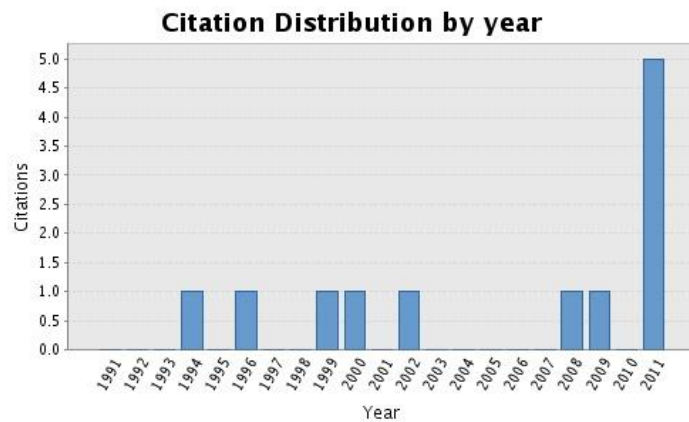
Research Interests - Water Quality and Water Management
Teaching Role – Water Quality and Pollution WATS 4530/6530

Nancy splits her duties between administration, extension and teaching. She is the Associate Dean for the College of Natural Resources and the Natural Resources Extension program leader. Her role as USU Extension Specialist in water quality and watershed science is described below. She also teaches one senior/grad level class (water quality and pollution) each year, as well as guest lecturing in several other classes each year. She mentors her own Masters students and serves on student committees in the colleges of NR, Engineering and Ag. She serves on multiple university committees, as well as the Utah NPS Task Force, Utah Water Monitoring Council, the Utah Watershed Coordinating Council.



She conducts research in support of her extension program and generates between \$100,000 and \$200,000 each year in competitive grants to support this work. Her general research interests include the effectiveness of nonpoint source best management practices, design and implementation of monitoring programs meet specific data objectives, and best practices for water science and watershed education and engagement.

Nancy teaches the Water Quality and Pollution course each fall semester. This course serves as one of the departmental capstone experiences for undergraduate students. Nancy is also the program coordinator for the Masters in Natural Resources degree program.



Total peer-reviewed articles: 7
Total number of citations: 12
Average citations per article: 2.40
h-index: 2

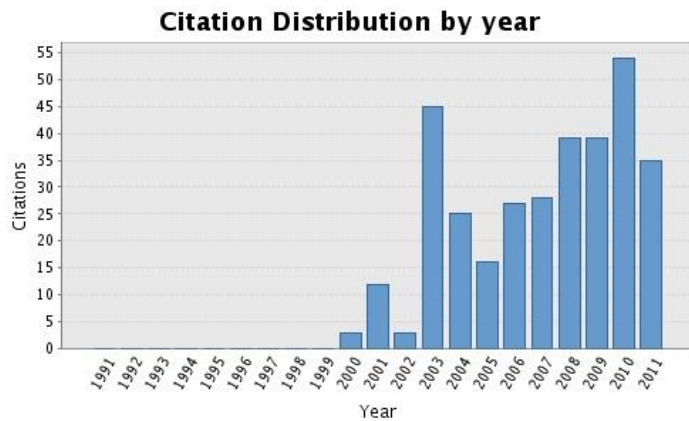
Dr. Jiming Jin, Assistant Professor

Research interests - Hydro-meteorological modeling, Regional weather and climate analysis
Teaching role – General Meteorology PCS 2000, Graduate seminar in hydroclimatology

Results of Jiming’s recent modeling and analysis indicate that recent changes in greenhouse gas emissions will significantly impact the climate of the Intermountain West. The western United States is dominated by diverse topography and complex ecosystems. However, densely distributed climate observations in both spatial and temporal domains for this region are not currently available, and such observations are essential to understanding climate change mechanisms and processes. Thus, realistic numerical computer models have become important tools for filling the gap. Currently, the major research in his group is focused on developing high-resolution regional climate simulations and forecasts for the western United States. Through these simulations and forecasts, we hope to gain a better understanding of climate change and variability over mountainous areas. Jiming is presently using an advanced regional climate model coupled with a sophisticated physical lake model to identify the role of small lakes in the regional climate system. These simulation results demonstrate that snowpack predictions are significantly improved due to more realistic snow surface energy parameterizations. These modeling results assist decision makers in managing water resources in the Intermountain West.



Dr. Jin teaches the General Meteorology class (3 credits) each fall semester and teaches a graduate class in climate and hydrologic modeling each spring.



Total peer-reviewed articles: 21
Total number of citations: 326
Average citations per article: 19.18
h-index: 9

Dr. Brett Roper, Assistant Professor, US-Forest Service, Aquatic Monitoring Center-Program Leader

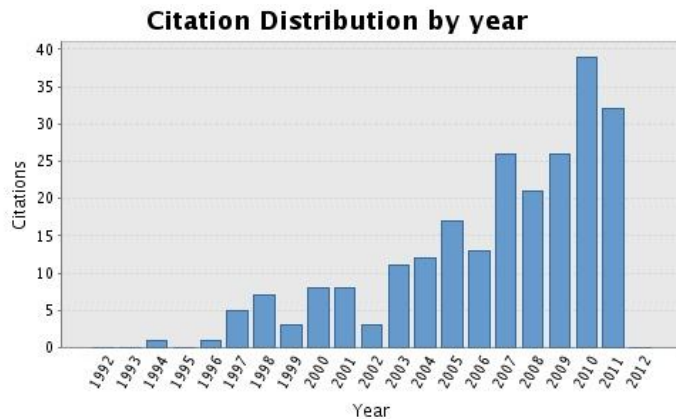
Research interests – Fish habitats, stream ecosystems

Teaching Role – Fisheries Management WATS 4650/6650, Analysis of Fisheries Data using R WATS 5650

The mission of the Forest Service Fish and Aquatic Ecology Unit is to identify emerging aquatic resource issues, develop technology to help address these issues, and transfer this technology to field biologists. Brett’s research works to provide scientifically sound, cost-effective technologies to aquatic resource specialists in support of the conservation and restoration of aquatic communities on Forest Service land. The Fish and Aquatic Ecology Unit works with federal and state research organizations and universities to develop technology to address emerging resource issues. Once this technology is developed we disseminate this technology to aquatic resource specialists through, continuing education workshops, presentations, publications, and on-site visits. Brett’s current research focuses on the development of methods to assess stream conditions for salmonid habitat.



Brett teaches Fisheries Management (3 credits) each spring. This course is offered to undergraduate and graduate students and is offered by graduate students in the MNR degree. Brett offers an on-line version of this class for students across the country. Brett also teaches a class using the statistical package “R” for students in both face-to-face and on-line settings.



Total articles in publication list: 28
Articles with citation data: 27
Total number of citations: 233
Average citations per article: 8.63
h-index: 10

Dr. Karin Kettenring, Assistant Professor

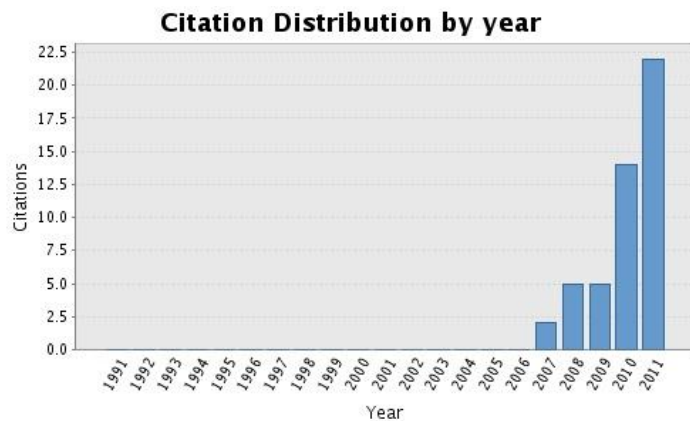
Research Interests - Wetland ecology: plants and restoration
Teaching Role - Wetland Ecology and Management WATS
4310/6310, Restoration Ecology WATS 6700

Karin's research addresses basic and applied questions related to wetland ecology, plant ecology, seed ecology, and restoration. More specifically, she and her students address questions concerning (1) What limits the restoration of wetland plant communities? (2) What role do plant species and genetic diversity play in restoring the structure and function of wetlands? (3) What makes invasive plants successful and how can we best manage them in wetlands? and (4) How do short and long-term drought affect wetland plant communities and their management?



Current related research projects examine (1) drivers of *Phragmites australis* (common reed) invasion and the restoration-potential of *Phragmites*-invaded wetlands in the Chesapeake Bay; (2) the effectiveness of different control techniques for *Phragmites* in Great Salt Lake wetlands; (3) mapping *Phragmites* invasion in northern Utah and evaluating mechanisms of emergence and spread; (4) pattern of genetic diversity of *Schoenoplectus maritimus* (alkali bulrush) and what patterns mean for seed collection for restoration; (5) the importance of genetic diversity of *S. maritimus* for ecosystem functions including invasion resistance of *Phragmites*; (6) a literature review and meta-analysis of drought effects on wetland plant communities.

Dr. Kettenring teaches the Wetland Ecology and Management course (3 credits) every spring semester and teaches Restoration Ecology (4 credits) with a faculty member in WILD every year.



Total peer-reviewed articles: 16
Total number of citations: 48
Average citations per article: 4.80
h-index: 4

Dr. Joseph Wheaton, Assistant Professor

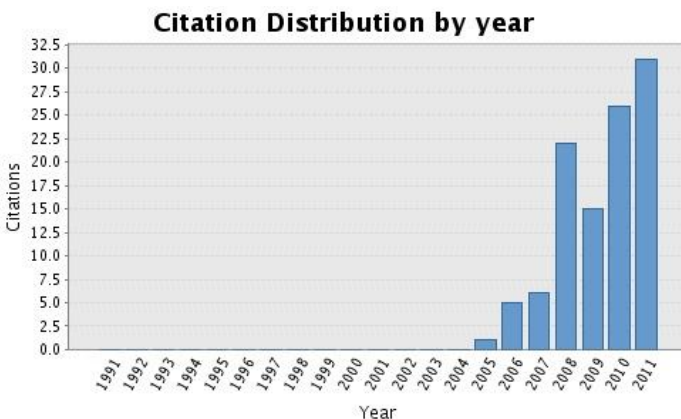
Research interests - Fluvial Geomorphology and Ecohydraulics

Teaching Role – GIS WATS 4930/6920, GIS Research Project WATS 4931/6931, Graduate seminar in Ecohydraulics

Joe's main interests are in fluvial geomorphology and ecohydraulics with a particular focus on linking the two (ecogeomorphology). He also has strong applied interests in the interface between environmental policy and science, and how uncertainties arising from each combine to influence the outcome of activities like river restoration. Joe's research is driven by a basic curiosity about how natural and disturbed river systems work. His research links geomorphic dynamics to ecohydraulics. The goals of his lab are develop a better understanding of to what extent geomorphic dynamics matter to aquatic and riparian species. We collect field datasets and produce models (e.g. MORPHED) that shed some light on this issue. We plan to more rigorously test long-standing conceptual models like the intermediate disturbance hypothesis and shifting-habitat-mosaic. One hypothesis is that physical systems exhibiting higher heterogeneity support higher biodiversity, and ecosystems with higher biodiversity may be more resilient to change. There are major challenges in documenting, explaining and predicting such changes and responses and my research in this area attempts to address such challenges and develop the means to test the above hypothesis. Currently our Ecogeomorphology and Topographic Analysis Lab (ETAL) is working with the US Geological Survey and Dinosaur National Monument to develop protocols for monitoring large canyon-bound rivers in the West. The ETAL lab (Joe Wheaton, WATS), Fluvial Geomorphology Lab (Jack Schmidt & Rebecca Manners, WATS), Remote Sensing Services Laboratory (Christopher Neale, Civil Engineering) and USGS (Mike Scott, adjunct WATS faculty) have conducted two research expeditions down the Yampa and Green Rivers to test and compare the use of emerging technologies like ground-based LiDaR, remote sensing using airborne-LiDaR and multi-spectral imagery surveys, traditional ground survey techniques using robotic total stations and survey-grade GPS, as well as traditional vegetation monitoring. For more information, visit: <http://www.joewheaton.org/Home/research/projects-1/big-river-protocol-development>



Joe teaches the GIS class each spring (3 credits) along with the associated projects class (2 credits). In spring he teaches a graduate seminar in EcoHydraulics and contributes substantially to our shortcourses in stream restoration.

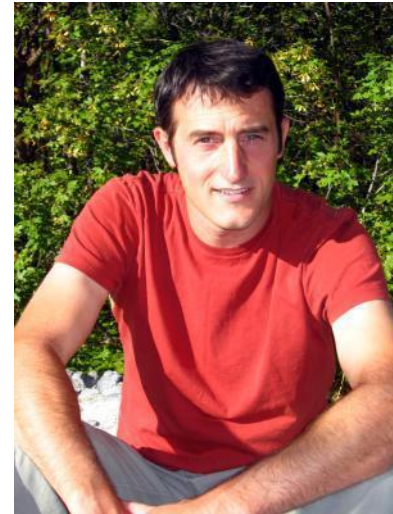


Total peer-reviewed articles: 13
Total number of citations: 106
Average citations per article: 11.78
h-index: 5

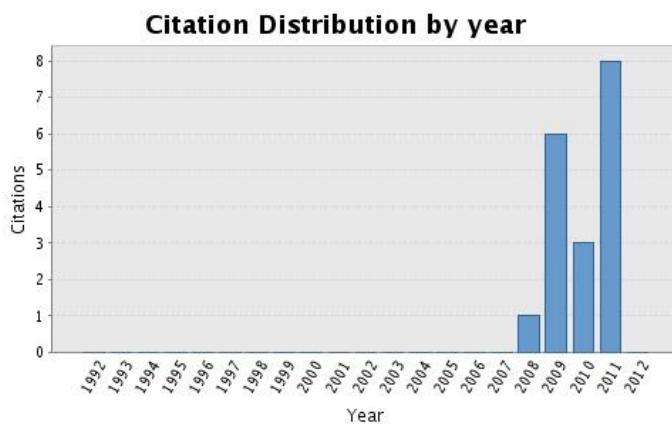
Dr. Patrick Belmont, Assistant Professor

Research interests - watershed hydrology, sediment dynamics, geomorphology, morphodynamics
Teaching Role – Small Watershed Hydrology WATS 4490/5490, Fundamentals of Watershed Sciences WATS 3700

Patrick’s research focuses on hydrology and geomorphology with specific interests in erosion and sediment routing at the watershed scale, landscape evolution, and human influence on water and sediment dynamics. His research spans basic and applied science, with ongoing projects examining scaling laws and spatial organization of topography, development of new techniques for sediment fingerprinting, and measurement of long- (millennial) and short-term (decadal to sub-annual) erosion rates at local and watershed scales. Ongoing field projects include sediment fingerprinting and development of sediment budgets for several watersheds in the Upper Mississippi River Basin, measuring long-term erosion rates in the southern Appalachian Mountains, understanding implications of long-term sediment supply and landscape context for fish habitat in the Columbia River Basin, and examining effects of climatic change on long-term erosion rates in Death Valley, CA. He published six peer-reviewed papers in 2011, one of which was highlighted by AGU as a Research Spotlight in *EOS* (Gangodagamage et al., 2011), and another of which was highlighted as an Editor’s Choice in *Science* (Belmont et al., 2011).



Patrick teaches the Small Watershed Hydrology course (4 credits) every spring semester. He also teaches the Fundamentals of Watershed Sciences every other year.



Total peer-reviewed articles: 6
Total number of citations: 18
Average citations per article: 3.00
h-index: 3

Dr. Sarah Null, Assistant Professor

Research interests – water resource management, climate change impacts, stream temperature management

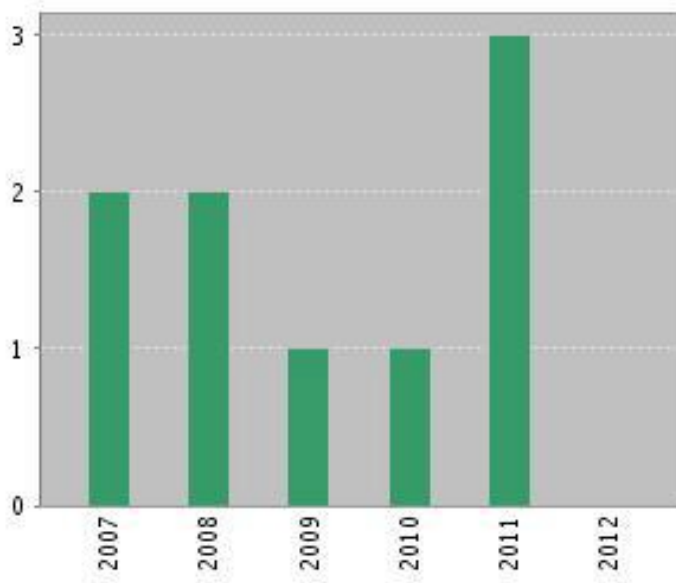
Teaching Role – Physical Geography GEOG 1200, Physical Geography Laboratory GEOG 1005, graduate seminar in modeling stream flow

Sarah’s main research interests are water resource management, river restoration, and improving information-sharing between policymakers, water managers, and researchers. Specific interests include re-operation of water systems to improve efficiency, dam removal, climate change impacts on water resources, and stream temperature management to improve habitat for aquatic species. Field studies, mathematical models, and systems analysis are methods she uses to improve understanding of systems and explore promising solutions to problems. An ongoing project includes stream temperature monitoring and modeling to evaluate thermal limitations of Lahontan cutthroat trout habitat in Nevada’s Walker River. Modeled flow and temperature data will increase understanding of river reaches and time periods which have poor habitat conditions for cutthroat trout, and will help improve management by highlighting promising restoration decisions for the Walker River.



Dr. Null teaches the Physical Geography course and associated laboratory each fall semester. This lecture class fulfills the breadth in physical sciences requirements for general studies at the University and as such has enrollments that exceed 200 students. She is developing her graduate seminar course in water modeling.

Citation Distribution by year



Total peer-reviewed articles: 3
Total number of citations: 3
Mean number of citations per article: 3
h-index: 2

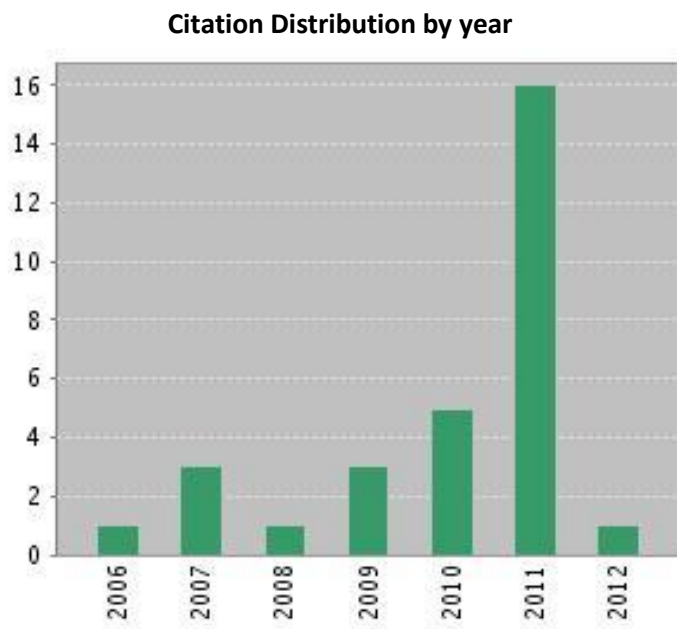
Dr. Scott Miller, Assistant Professor and Director, US-BLM National Aquatic Monitoring Center

Research interests - Freshwater and riparian ecology, stream restoration, and biomonitoring
Teaching Role – Freshwater Invertebrates WATS 5550

Scott is Director of The National Aquatic Monitoring Center (NAMC); a cooperative agreement between Utah State University and the U.S. Bureau of Land Management which seeks to encourage and foster scientifically sound watershed monitoring programs on public lands. NAMC provides five fundamental services to BLM field offices and other state and federal agencies: 1. Processing aquatic macroinvertebrate samples; 2. Database development and maintenance for over 50,000 macroinvertebrate samples; 3. Freshwater bioassessment trainings; 4. Assistance with the design, implementation, and interpretation of aquatic biomonitoring programs; and 5. Research to address watershed management issues and advance the science and practice of aquatic biomonitoring. Scott is currently working with the BLM and their partners (e.g., USFS, EPA, NPS) to develop a national aquatic monitoring strategy to assess the status and trend of BLM freshwater resources. As a community ecologist, Scott's research seeks to understand who lives with whom and why and how natural and anthropogenic disturbances alter species' distributions. The main focus of such studies is aquatic and terrestrial insects, freshwater fishes and riparian vegetation. His current research focuses on understanding responses of stream systems to hydrologic alterations, grazing impacts to riparian and aquatic ecosystems and modeling spatiotemporal variability in macroinvertebrate assemblage dynamics.



Scott teaches the Freshwater Invertebrates course (3 credits) each spring semester. This lecture and field course is taken by students in WATS and Biology.



Total peer-reviewed articles: 4
Total number of citations: 30
Average number of citations: 7.5
h-index: 3

Mark Larese-Casanova, Extension Education Specialist

Extension interests – environmental education, education assessment

Mark has developed the Utah Master Naturalist Program (UMNP) to address the need for increased environmental literacy among the general public, volunteer naturalists, and professionals. The overarching goal of the UMNP is to "develop a corps of well-informed Master Naturalists who provide education, outreach, and service to promote citizen stewardship of natural resources within their communities." By connecting Utah citizens with the local natural resources within their communities, the UMNP educates an increasingly urbanized population to positively affect the public's awareness and involvement in natural resources conservation. The UMNP strives to not only directly educate Utah citizens, but also to train volunteers and professionals to deliver education programs to this population. The UMNP educates participants in three different systems-based modules: Utah Watershed, Utah Deserts, and Utah Mountains. The 40-hour Watersheds and Deserts modules of the UMNP have been taught several times, and 75 people have completed at least one, and often both, of these modules. In 2010, the UMNP will be offered to 36 Utah schoolteachers to improve their knowledge and to provide them with opportunities and resources to better teach their students about conserving Utah's natural ecosystems. The UMNP has proven to be an effective program with which to build partnerships between USU and several federal and state agencies, non-profit organizations, and universities.



STAFF

The Department of Watershed Sciences employs two outstanding staff personnel. Enid Kelley is the administrative assistant (Staff Assistant, Senior), and has been in this position since the College was reorganized in 2003. Enid's position is currently funded at 0.9 FTE. Enid provides administrative support for the department head. In addition to typical office duties, Enid manages the department web site, keeps faculty records and tenure and promotion files up to date, and manages the payroll process for faculty and staff in the department. Enid Kelley receives outstanding reviews from the faculty and students, and makes a very positive first impression for everyone that enters the office door. The success of our department would be greatly diminished without Enid's friendly smile, positive attitude, and ability to get things done at the University.



Brian Bailey is the student support staff (Staff Assistant II), a position that is funded at 0.75 FTE so that Brian can pursue his MS degree in Psychology. Brian is exceptionally efficient at serving the graduate students in our department. He maintains files and manages the tuition remission program with the School of Graduate Studies. He also maintains databases on student records and manages the employment paperwork for our graduate students. Brian serves as the reader for departmental theses and dissertations to make sure that formatting procedures have been followed. Brian has been instrumental in editing the graduate student handbook that provides guidance to our students as they move through the requirements of their degree programs. In addition to his work with our graduate program, Brian provides logistical support for short courses and field trips, and helps with the delivery of large classes. Both Brian and Enid create a very positive work environment and support each other in their various tasks. Their "can do" approach to office management allows the department to function well even when these staff positions have been recently reduced to levels below 100%.



In addition to Enid Kelley and Brian Bailey, the department often employs a student assistant who is paid hourly to assist with various office tasks. We have been fortunate in often having very competent people fill this role. This position is currently not funded but we are searching for a suitable person to fill this role. Enid and Brian work to help fill this position.

STUDENTS

The undergraduate majors in our department are typical of the undergraduate population at the University. Most are Utah residents (83%) and few come from foreign countries (2%). Current student gender breaks down to 77% male and 23% female and come mostly from the metropolitan areas along the Wasatch Front (Provo-Orem, Salt Lake-Ogden, and Cache Valley). Freshman entering the BS degree programs must meet the academic standards of the University (admission index of 90 consisting of ACT score exceeding 18 and a high school GPA of 2.6). Transfer students must have a GPA of 2.5 (out of 4.0) from coursework completed at their previous institutions. Approximately 57% of our undergraduate majors has transferred into our programs from another academic institution.

Current undergraduates in the Fisheries and Aquatic Sciences majors in the department maintain a mean GPA of 2.8. These students are taking rigorous science courses in biology, chemistry, physics and

one semester of calculus. Undergraduate students in the Watershed and Earth Systems BS degree maintain an average GPA of 2.9. Requirements for this degree include courses in geology, chemistry, physics and two semesters of calculus.

Courses taught by WATS faculty generate approximately 1800 student credit hours per academic year (Figure 9). A majority of these SCHs derive from the courses that fulfill general education requirements, such as the breadth in sciences courses of Physical Geography (Geog 1000) and Biodiversity and Conservation (WATS 1200), and general education depth in science courses Oceanography (WATS 3000), Fish Diversity (WATS 3100), and Fundamentals of Watershed Sciences (WATS 3700). Each of these courses are taught once per year. The decline in SCHs in 2007-08 was due to a reduction in faculty lines.

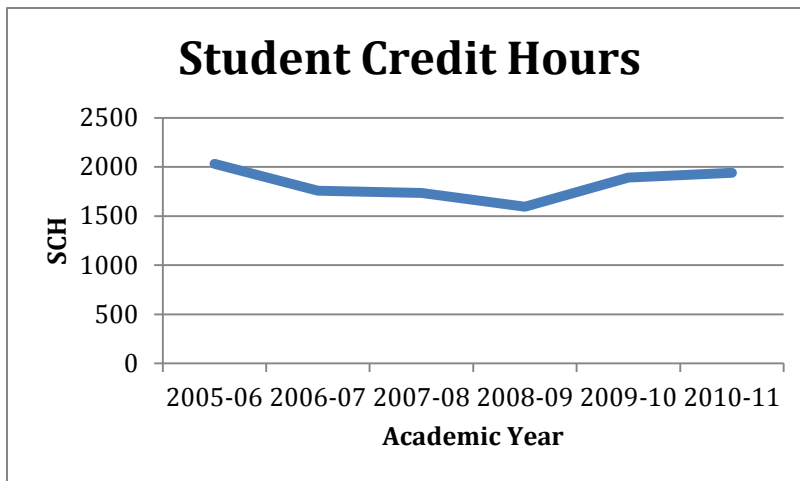


Figure 9. The number of Student Credit Hours (SCH) generated by courses taught by faculty or staff in the Watershed Sciences Department.

The number of SCHs per funded faculty lines in the department has remained at approximately 300 during the past six years. This value declined a bit in the 2008-09 academic year, but has increased slightly during the past two years (Figure 10a). The ratio of full-time equivalent (FTE) students to FTE faculty for undergraduates has varied considerably during the past six years, ranging from a high of 27 in 2005-06 to a low of 5.8 in 2007-08 (Figure 10b). This ratio for graduate students has been more stable ranging from a high of 9.8 in 2008-09 to a low of 5.8 in 2007-08.

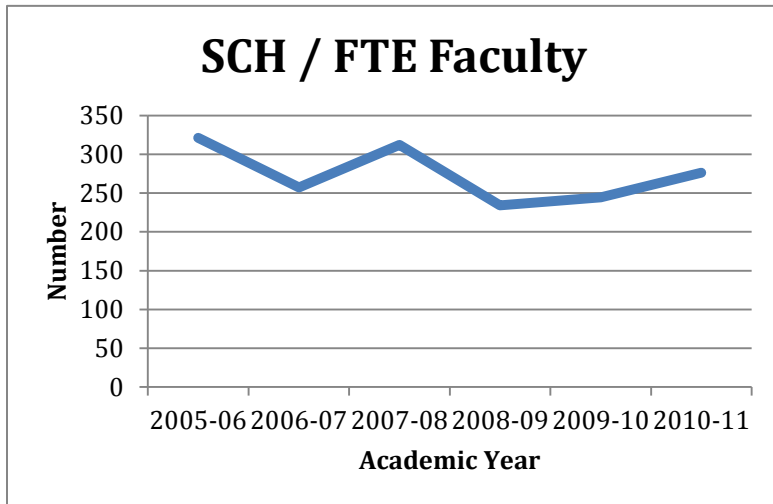


Figure 10a. SCHs per funded faculty line

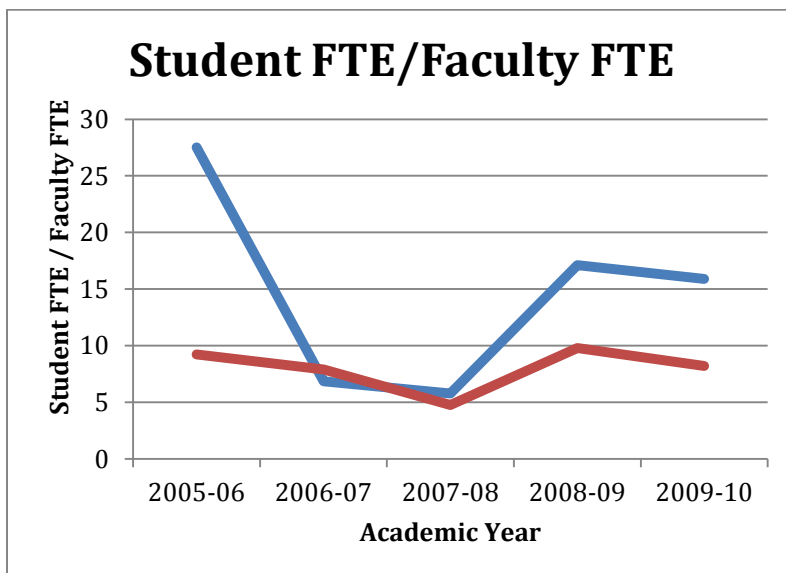


Figure 10b. Ratio of FTE students to FTE faculty

This variation in student credit hours and Student FTE/Faculty FTE derives mainly from changes in the number of faculty present in the department in different years. Drs. Mike White, Matt Baker, and Tamao Kasahara all left our department to take employment at other institutions from 2005-2008. The recent hires of Drs. Joe Wheaton, Patrick Belmont, and Sarah Null have replaced those losses and allowed for our teaching activities to expand. The increase in student numbers at USU during the past three years also contributed to recent increases in SCHs.

The number of students completing their BS, MS, and PhD degrees in the Watershed Sciences Department has ranged from 16 in 2005-2006 to 9 in 2008-2009 (Figure 11). Nineteen students completed their degrees in the 2010-11 and a similar number of students are expected to finish during the current academic year.

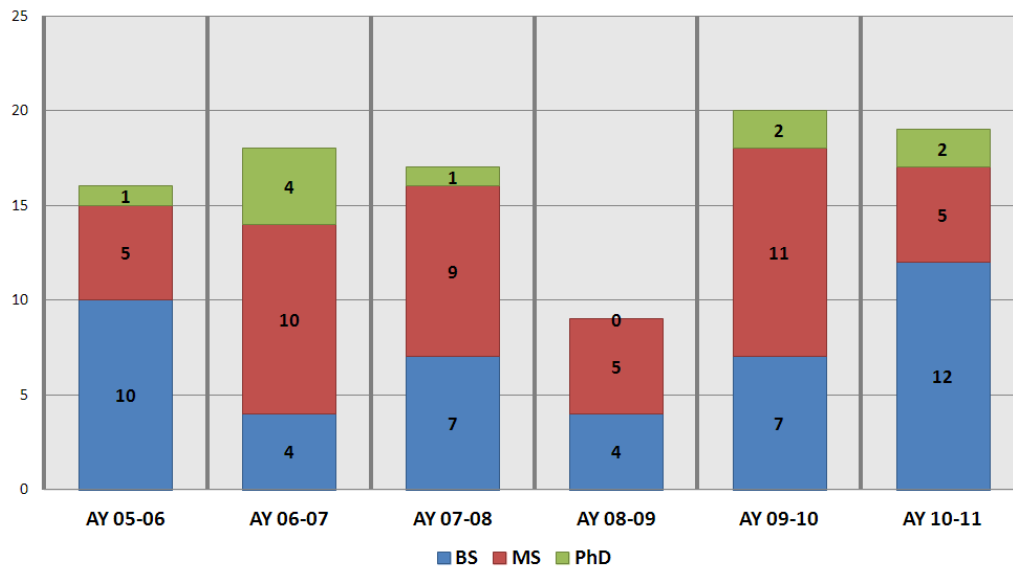


Figure 11. Students completing BS (blue), MS (red), and PhD (green) degrees in the Watershed Sciences Department during the past 6 years.

The retention rate for students in these degree programs is high relative to other programs at the University and at other Universities. The BS in Fisheries and Aquatic Sciences and the BS in Watershed and Earth Systems are relatively new degree, being established in 2003. The annual retention rate for students in these two degree programs has averaged 73% and 84% respectively. The MS and PhD degree in Fisheries Biology, Watershed Science and Ecology have been in place for several decades. Retention rates in these programs approaches 90%.

PROGRAM COSTS

The cost of our department activities to the State of Utah budget is less than \$1M per year. Most of these expenses (94%) come from salaries and benefits of eight faculty and two staff. Less than 5% of the state supported expenses provide funds for operating.

Research activities in the department come almost entirely from contracts and grants. During the past two years, faculty have been successful at securing over \$5M annually in external funds to support the research and extension missions of the department. These funds are also instrumental in providing stipends for graduate students and employment for many of our undergraduates. The overhead return to the department from research grants amounts to approximately \$90k annually. Forty percent of these funds are returned to the faculty that generated the grant. The remaining funds are used to support faculty activities, provide for upkeep on departmental vehicles, fund recruitment activities for prospective graduate students, and provide funds for the purchase and replacement of research equipment. The generous overhead return rates provided at this University allow departments to assist faculty research activities and develop attractive start-up cost for new faculty members. Without the current overhead return to departments, the ability of the Department of Watershed Sciences to pursue research programs would be greatly compromised.

We pay for teaching expenses from departmental operating budgets and also from course fees associated with laboratory and field-based courses. These course fees provide for approximately \$8000

annually and allow the Department to continue our efforts to provide hands-on, field-based educational experiences to our undergraduate and graduate students. Our faculty are committed to providing students with the best possible education by giving of their time to conduct extensive field trips, develop laboratory exercises using state-of-the-art analytical methods, and provide new statistical, computational, and geospatial approaches to addressing natural resource issues. This commitment is demonstrated by the time faculty devote to their teaching assignments and by their willingness to allow students access to equipment, boats, and environmental sensors used in their research laboratories.

The value of our educational activities to the public is demonstrated by contributions of time and money from governmental agencies, non-profit organizations, and private environmental firms. Pacificorp, Friends of the Great Salt Lake, Trout Unlimited, and several environmental consulting firms assist us with our capstone courses. Both state (UDWR, UDWQ, UDFSL) and federal (USGS, USFS, USBLM, NOAA) interact with our students by visiting classes, working with faculty to establish course objectives, and assisting students with independent research projects. Our high-touch educational programs are expensive to deliver, but provide students who are motivated, well-trained, and prepared to take on the challenges of working for the enhancement of environmental quality in our water, landscape, and biotic resources.

PROGRAM SUPPORT

Facilities and Equipment

Students have access to the Merrill-Cazier Library on campus. The library provides access to most of the needed journals and book resources necessary for completion of our degree programs. The Merrill-Cazier Library is undergoing a transition to provide digital resources for most journals and for many books. Students and faculty can access these digital resources from their computers. This system has greatly simplified the use of journal material in classes.

The department owns a number of boats and two vehicles to use in field exercises. Additional vehicles are available for the University motor pool or from private vehicle rental companies. Faculty members frequently allow the use of research vehicles and other equipment for teaching purchases. The department sometimes pays for the use of these items through service contracts.

University support is also present for animal care approvals and for hazardous waste disposal so that animals and chemicals can be easily used in classroom, laboratory, and field exercises. The Institutional Animal Care and Use Committee (IACUC) has been extremely helpful in providing information and assistance to faculty who work with animals in their teaching and research programs. The use of radioactive materials and other hazardous chemicals is made possible by efficient university policies as administered by the Environmental Health and Safety Office (EHS).

Support from donors to the College of Natural Resources is also directed to facilities that enhance the educational mission of the Watershed Sciences Department. The S.J. and J.E. Quinney Foundation provides annual gifts to maintain and upgrade the Quinney Natural Resources Library. This facility houses two computer labs with software licenses to allow student to learn the latest geographic information science, remote sensing platforms, and statistical approaches. Undergraduate students in our three BS degree programs are required to take two courses in geographic information systems. Many students also take a class in remote sensing and a class in biometry. These courses are taught in the computer laboratories located in the Quinney Library. Additional courses in population dynamics, hydrology, fisheries, and genetics make use of these library resources.

Professional Development

The University offers the Teaching Academy for all new faculty. This program has been very well received by new faculty members. The master teachers who teach the curriculum for the program provide good advice and helpful examples of how to become an excellent educator. The College of Natural Resources provides travel support for faculty to attend professional meetings designed to enhance faculty teaching abilities. Several, but not all faculty in the Watershed Sciences Department have made use of these funds. If annual performance reviews of faculty indicate that teaching is a struggle, individuals have been directed to attend these programs in the individual's area of expertise.

Several faculty have attended workshops on grant-writing provided by the Vice President for Research Office on campus. These workshops provide both strategic and tactical advice on ways to fund research programs. The department and the college will work with young faculty to assist them in participating in additional research-oriented workshops or symposia. Travel funds for meeting with program managers of funding agencies are also available.

PROGRAM ASSESSMENT

The overarching mission of our department is to foster discovery, learning, and application of knowledge about aquatic ecosystems to promote stewardship of the environment. We strive to accomplish this mission through our teaching, research, and extension programs. To achieve this mission we focus on developing methods to 1) assess the status of aquatic resources, 2) to preserve intact natural ecosystems, and 3) to restore degraded ecosystems to enhance ecosystem services and environmental quality for the good of society. These three goals are woven throughout the teaching, research, and extension programs in the department. We assess our progress in achieving these goals in these three program areas in a variety of ways. The BS degree programs in Fisheries and Aquatic Sciences, Watershed and Earth Systems, and Geography are evaluated through standard university course evaluations, through exit interviews with graduating seniors, and through placement surveys conducted after students have completed their degree. Graduate programs are evaluated through the quality of students admitted to the program, the quality of theses and dissertations completed, and placement of students in positions after completion of their degree requirements. Evaluation of the research programs in the department includes assessment of the portfolio of research grants received by faculty, a summary of publications of faculty scholarship, an assessment of annual and career citations to faculty publications, and assessment of faculty service to scientific societies, governmental agencies, and review boards. Evaluation of the department's extension programs occurs in consultation with the Vice President of University Extension. This evaluation includes a summary of extension activities for each extension faculty, the impact of these activities on target audiences, and the change in behavior of user groups in response to extension programming.

Undergraduate Degree Programs

The course evaluation system at USU indicates that the department is about average in providing courses that satisfy student needs and expectations. These evaluations are not terribly helpful in that the majority of courses earn scores that are within half of a standard deviation of the mean values. A variety of statistical analyses of the course evaluations suggest that class size is the only general factor impacting the evaluations provided by students. This information on course evaluations does alert us if a course receives either a very low or very high score in terms of "instructor effectiveness" or "course quality". The department head provides assistance to individuals receiving low scores or uses the

information from high scores in annual performance evaluations and consideration for merit pay increases. These standardized course evaluations do provide students an opportunity to point out strengths and weaknesses of the course. These written comments are very helpful for faculty in their efforts to improve their courses. The department head and faculty member discuss the generalities present in these comments and develop plans to implement changes in the course. Students also send us updates on progress in their careers. A few of these testimonials are presented in Appendix 4. A new system of course evaluations began in the fall of 2011 and may provide a better vehicle to evaluate individual courses and instructors.

In our current system, the exit interviews (Appendix 5) of graduating seniors provide the best input on ways to improve our undergraduate curricula. The department head conducts an informal discussion with individual students or small groups of student to get a sense of the strengths and weaknesses of each degree program. The students are asked to fill out a form ranking the learning objectives of each course on a scale of 1 to 10. A summary of these rankings are presented in Table 8. A summary of comments from exit interviews and the ranking of learning objectives are discussed at the annual departmental retreat. During these discussions, faculty develop ways to modify existing courses or develop new courses to better meet the needs of our students in their efforts to become professionals in their chosen fields of study.

A placement survey of alumni graduating during the previous year gives us additional insight into the strengths and weaknesses of our degree programs. A summary of this placement survey for the past several years is presented in Table 9. This information provides the department with a better perspective of what students do after they complete their undergraduate degree programs. Results of these surveys indicate that about 30% of our undergraduates go on to pursue graduate degrees, about 40% work for state or federal institutions (including universities), and approximately 10% work for private environmental firms. Twenty percent of the graduates that responded to our survey found employment in positions not related to their degrees.

Table 8. Learning Objectives for Undergraduate Courses

		Learning objectives for undergraduate courses required for BS degrees in Watershed and Earth Systems (WAES), Fisheries and Aquatic Sciences (FAAS), and Geography (GEOG).																					
		Learning Objectives for Departmental BS Degrees								WAES				FAAS				GEOG					
Required Courses	Outcomes	Gain factual understanding of climate-hydrological-ecological systems (1)	Gain factual understanding of biogeochemical cycling of Carbon, Nitrogen, Phosphorous	Application of knowledge to analyze ecosystem services. (3)	Critical evaluation of impact of humans on earth (11)	Develop skills in spreadsheet analyses (4)	Statistical competence in ANOVA, regression (4)	Learning fundamental principles of hydrology (2)	Develop competence in GIS (4)	Develop writing skills for science applications (8)	Develop oral communication skills (8)	Develop competency in hydraulics and sediment transport in streams (4)	Develop ability to make measurements of stream discharge, hydraulic forces, channel features (4)	Application of remotely sensed data to analyze environmental problems (3)	Learning principles of the biology of aquatic organisms (2)	Gaining knowledge of habitat requirements of aquatic organisms (1)	Application of biological principles to analyze population dynamics (3)	Critical assessment of human impacts on biodiversity (11)	Develop skills in measurements of abundance, biomass, growth of organisms (4)	Learn fundamental concepts in physical geography (2)	Develop skills to collect and analyze geographic field data (4)	Learning fundamental concepts of earth systems and interactions (2)	
		WATS 1020 Professional Orientation				8	8.5																
Geog 1000 Physical Geography																							
Geog 1005 Physical Geography Lab																							
Geog 1800 Intro to GIS																							
WATS 3000 Oceanography		9	8.5	9	9																		
WATS 3100 Fish Diversity & Conservation									7.7						8.9			8.5					
WATS 3110 Fish Diversity Lab										7.7					9.2				8.9				
WATS 3700 Fundamentals WATS Science		8.5	6.9	7.9		6.2			8.2														
WATS 3820 Climate Change		8.5	6	4	8.5																		
WATS 4490/6490 Small Watershed Hydrology		7.7				7.5							8.3										
WATS 4500/6500 Limnology			9.3	6.3											8.9								
WATS 4510 Aquatic Ecology Practicum						9.5	8.3		9.7						9.1				9.3				
WATS 4530/6530 Water Quality and Pollution					9.5				9.3										9				
WATS 4650/6650 Principles in Fishery Mgmt																8.9	8.7	8.9					
WATS 4930/6920 Adv GIS & Spatial Analysis								7.9															
WATS 4980/6800/7800 Dept Seminar									8.5	8.5													
WATS 5150/6150 Fluvial Geomorph				6	6.8		9.2				9.2												
WATS 5170/6170 Fluvial Geomorph Lab					7.8		8.8				8.8	9.5											
WATS 5200 Fish Habitats																10							
WATS 5550 Freshwater Inverts															10	10			10				
WATS 4310/6310 Wetland Ecology and Mgmt																							
WATS 5640/7640 Riparian Ecol & Mgmt																							
WATS 5650 Analysis Fisheries Data w/R																							

Table 9. Summary of Placement Survey of Watershed Sciences Alumni

FAAS: Alumni				Placement Data
AY 2010-2011 (7 Graduates)				
Jensen	Kirt	Summer	2010	US National Guard
Cook	Colin	Fall	2010	Unknown
Crawford	Joseph	Fall	2010	Grad. Student at USU
Leonard	Ryan	Spring	2011	Lab technician at USU
Marrett	Benjamin	Spring	2011	Unknown
Wight	Jaclyn	Spring	2011	Grad. Student
Wilcox	Meagan	Spring	2011	Hillyard, Anderson, and Olsen Law Firm
AY 2009-2010 (4 Graduates)				
Collins	Deborah	Fall	2009	USU BugLab
Abbott	Jonathan	Spring	2010	Animal Care Facility at USU
Lamarra	Daniel	Spring	2010	Environmental Consulting Firm
Rowley	Gilbert	Spring	2010	Fly Tyer; Fly Tying 123
AY 2008-2009 (3 Graduates)				
Mason	Paul	Fall	2008	Trout Unlimited
Randall	Jared	Fall	2008	MS Student at Utah State University
Braithwaite	Nicolas	Spring	2009	UDWR
AY 2007-2008 (3 Graduates)				
Low	Chad	Spring	2008	Sales Account Manager; Juniper Systems; Salt Lake City, UT
Stoller	Jacob	Spring	2008	MS Student at Central Michigan University
Wilgar	Jaculine	Spring	2008	California Conservation Corps
AY 2006-2007 (4 Graduates)				
Baron	Kaisi	Fall	2006	DWR Habitat Section (Part-time)
Garr	Daniel	Fall	2006	Mechanic, Chevron; North Salt Lake
Pearce	Weston	Fall	2006	Taxidermist; Oakley, Utah
Allen	Cody	Spring	2007	MS Student at Utah State University
AY 2005-2006 (4 Graduates)				
Smith	Jared	Summer	2005	Fish Culturalist; Dubois Fish Hatchery, WY
Horrocks	Jessica	Fall	2005	Unknown
Kroeber	Chris	Spring	2006	Plans & Operations Officer; Utah National Guard; Provo, UT
Rogers	Ronald	Spring	2006	Fisheries Biologist; BIO-WEST
WAES: Alumni				Placement Data
AY 2010-2011 (3 Graduates)				
Babb	Shannon	Fall	2010	Graduate Student at USU
Saltzman	Alan	Spring	2011	Watershed Coordinator; Utah Association of Conservation Districts
Montrone	Ashton	Spring	2011	Graduate Student at University of Nevada, Reno
AY 2009-2010 (3 Graduates)				
Elsner	James	Fall	2009	Project Coordinator; Cache County Extension
Kang	Michelle	Spring	2010	Graduate Student at Portland State University
Stout	Justin	Spring	2010	Graduate Student at Utah State University
AY 2008-2009 (1 Graduate)				
Abbott	Benjamin	Spring	2009	PhD Student at University of Fairbanks, Alaska
AY 2007-2008 (4 Graduates)				
Bingham	Quinten	Summer	2007	MS in CEE at Utah State University;
Baillie	Marshall	Fall	2007	MS in WATS at Utah State University
Bowcutt	James	Fall	2007	Bear River Watershed Coordinator; USU Extension
Downey	Blake	Spring	2008	Environmental Consulting
AY 2006-2007 (0 Graduates)				
AY 2005-2006 (6 Graduates)				
Myers	Andrew	Summer	2005	Hydrologic Technician, USGS; Moab Field Office
Jensen	Benjamin	Fall	2005	Unknown
Nielson	Ashley	Fall	2005	Completed MS degree, now works for NOAA in Salt Lake City
Bhattachan	Abinash	Spring	2006	PhD Student in Dept. of Environmental Sciences at Univ. of Virginia
Gibson	Jacob	Spring	2006	MS Student in the WILD Dept. at Utah State University
Russell	Holly	Spring	2006	Unknown

WATS Undergraduate Placements: Government (G)=6, 16%; Academia (A)=5, 14%; Consulting (C)=4, 11%; Continuing Education (E) 13=35%; NGO (N)=3, 8%; Other (O)=6, 16%. Total Graduates 42. Number of Responses 37. Percent Responded 88%.

Graduate Alumni, Degrees, & Emphases						Placement Data
AY 2011-2012 (1 Graduate)						
Braithwaite	Nicolas	Summer	2011	MS	Fisheries Biology	UDWR
AY 2010-2011 (7 Graduates)						
Bisrat	Simon	Summer	2010	PhD	Ecology	Modeling Analyst, Oregon State University
Garrett	Jessica	Fall	2010	MS	Ecology	Hydrologist; USGS Iowa Water Science Center
Gebreab	Samson	Fall	2010	PhD	Ecology	Data Analyst; University of Michigan
Hill	Andrew	Fall	2010	MS	Watershed Science	Research Biologist; BPA's Columbia Habitat Monitoring Program
Schulz	Amanda	Fall	2010	MS	Watershed Science	United States Peace Corps Volunteer
Weber	Nicholas	Fall	2010	MS	Ecology	Project Researcher; Utah State University
Epstein	David	Spring	2011	MS	Ecology	Lab technician; Utah State University
AY 2009-2010 (12 Graduates)						
Dean	David	Summer	2009	MS	Watershed Science	Fluvial Geomorphology Lab Manager; Utah State University
Hein	Catherine	Summer	2009	PhD	Ecology	Post doctoral researcher at Umeå University, Sweden
Johnson	Cody	Summer	2009	PhD	Ecology	Post doctoral researcher at the Ecosystem Center, Woods Hole
Kraft	Stephanie	Summer	2009	MS	Ecology	PhD Student; Oregon State University
Seidel	Sara	Summer	2009	MS	Fisheries Biology	Bank Teller; Fishtail, Montana
Van Appledorr	Molly	Summer	2009	MS	Ecology	PhD Student; University of Maryland, Baltimore
Bottcher	Jared	Fall	2009	MS	Watershed Science	Fish Biologist, USGS; Klamath Falls
Burke	Amy	Fall	2009	MS	Watershed Science	Hydrologic Technician; Montana Snow Surveys; NRCS
Kennedy	Patrick	Fall	2009	MS	Watershed Science	US Forest Service, Idaho
Lockwood	Ryan	Fall	2009	MS	Ecology	US Forest Service, Colorado
Landom	Kevin	Spring	2010	MS	Fisheries Biology	Project Coordinator; Utah State University
Scully	Rebecca	Spring	2010	MS	Watershed Science	USDA Forest Service; Logan, UT
AY 2008-2009 (5 Graduates)						
Bissonette	Gabriel	Summer	2008	MS	Ecology	Bureau of Land Management; Moab, UT
Goetz	Randy	Summer	2008	MS	Ecology	Hydrologist; Interfluve
Nadolski	Benjamin	Summer	2008	MS	Fisheries Biology	Fisheries Biologist, UDWR; Ogden, UT
Wood	Jeremiah	Summer	2008	MS	Fisheries Biology	Regional Fisheries Biologist, Montana Fish, Wildlife, and Parks
Dahle	Samuel (Ki)	Spring	2009	MS	Ecology	Project Coordinator, Bear River Native Trout Program; Trout Unlimited
AY 2007-2008 (10 Graduates)						
Birchell	Garn	Summer	2007	MS	Fisheries Biology	Fisheries Biologist, UDWR; Vernal, UT
Harju	Tarita	Summer	2007	MS	Watershed Science	Idaho Fish and Game; Panhandle District
Hansen	Eriek	Fall	2007	MS	Ecology	PhD student at the University of Wyoming
Moon	Michael	Fall	2007	MS	Ecology	NOAA Fisheries; Seattle
Nelson	Nicholas	Fall	2007	MS	Ecology	Geomorphologist; Innerfluve; MA
Alexander	Jason	Fall	2007	MS	Watershed Science	Hydrologist, USGS; Nebraska Water Science Center
Turner	Melissa	Fall	2007	MS	Watershed Science	Stay-at-home mother
Caires	Andrea	Spring	2008	MS	Ecology	Research Faculty, University of Nevada, Reno
Bennett	Stephen	Spring	2008	PhD	Fisheries Biology	Post-doctoral Researcher; Utah State University
Myers	Andrew	Spring	2008	MS	Watershed Science	Hydrologic Technician, USGS; Moab Field Office
AY 2006-2007 (14 Graduates)						
Buelow	Kris	Summer	2006	MS	Fisheries Biology	PhD student at Montana State University
Gagstetter	Nicol	Summer	2006	MS	Watershed Science	Senior Advisor for Sustainable Development; Kennecott Copper
Kikkert	Dave	Summer	2006	MS	Ecology	Graduate Student at Texas State
Marcarelli	Amy	Summer	2006	PhD	Ecology	Assistant Professor; Michigan Technological University
McHugh	Peter	Summer	2006	PhD	Fisheries Biology	Post Doc, Freshwater Ecology Research Group; University of Canterbury
Shakespeare	Brooke	Summer	2006	MS	Watershed Science	Dixie National Forest
Vatland	Shane	Summer	2006	MS	Ecology	PhD Student at Montana State University
Walker	Andree	Summer	2006	MS	Watershed Science	Executive Director; The Utah Society for Environmental Education
Al-Chokachy	Robert	Fall	2006	PhD	Ecology	Fisheries Biologist; USDA Forest Service
Koenig	Martin	Fall	2006	MS	Fisheries Biology	Senior Research Fisheries Biologist, Idaho Dept. of Fish & Game
Robinson	Justin	Fall	2006	MS	Fisheries Biology	Fisheries Biologist; Dept. of Natural Resources
Zarnetske	Jay	Fall	2006	MS	Watershed Science	PhD Student at Oregon State University
Burkart	Greta	Spring	2007	PhD	Ecology	Research Professional; International Arctic Research Center
Hemel	Kristen	Spring	2007	MS	Fisheries Biology	PhD Student at Montana State University
AY 2005-2006 (6 Graduates)						
Billman	Eric	Fall	2005	MS	Ecology	PhD Student; Brigham Young University
Heartsill-Scall	Tamara	Fall	2005	PhD	Ecology	USDA Forest Service, International Inst. of Tropical Forestry
Ratcliff	Donald	Fall	2005	MS	Ecology	Biologist, US Fish & Wildlife Service
Rigsby	Leah	Fall	2005	MS	Ecology	Consulting Firm in Atlanta, GA; Return for PhD soon
Adams	Pauline	Spring	2006	MS	Ecology	Works for Forest Service in Colorado
Mackinnon	Peter	Spring	2006	MS	Fisheries Biology	Research Associate; Utah State University

WATS Graduate Placements: Government (G)=21, 38%; Academia (A)=14, 25%; Consulting (C)=4, 7%; Continuing Education (E) 9=16%; NGO (N)=3, 5%; Other (O)=4, 7%. Total Graduates 55. Number of Responses 55. Percent Responded 100%.

Graduate Degree Programs

We strive to admit students with the very best undergraduate credentials into our graduate degree programs. We monitor the mean composite GRE scores of graduate applicants and accept prospective students with GRE scores above 1100 and undergraduate GPAs of 3.2. Students with lower GRE scores or lower undergraduate GPAs are occasionally admitted after a suitable justification for such admission has been approved by our departmental graduate selection committee and the department head. The current graduate students in our MS and PhD degree programs have a mean composite GRE score of 1190 and their current USU GPA exceeds 3.7. Our examination of GRE scores and undergraduate GPAs of past students have provided guidance to us in graduate acceptance procedures. Past students with GRE composite scores of less than 1000 have had difficulties in completing their degree work, often leaving the program after several semesters.

Our graduate students generally succeed in publishing their thesis and dissertation research. During the past 6 years, present and past graduate students have published over 84 articles in peer-reviewed journals. This level of production represent 1.5 publications per graduate student.

More than 90% of the graduates of our MS and PhD programs from the past 6 years have found employment in their chosen field of study or have gone on to additional graduate education. The placement survey of these alumni is presented in Table 8. Most of our students completing graduate degrees find employment with state or federal natural resources agencies (40% of respondents). An additional 25% of former graduate students work at universities as either research associates or faculty. Approximately 20% choose to continue their education in PhD programs, and 10% find employment with private consulting firms or non-profit organizations.

The educational program of the Department of Watershed Sciences was recently recognized as the recipient of Utah State University's *2011 Department Teaching Excellence Award*. At the presentation of the award, USU President Stan Albrecht said, "The Department of Watershed Sciences has consistently upheld the highest teaching standards to, first and foremost, assure the success of its students. On behalf of the university, I present this award with sincere congratulations." In a written citation, the department was praised for "never [wavering] in its commitment to make students aware of human impacts in the natural world and our responsibility for stewardship of the planet's environment and its precious natural resources." The citation described Watershed Sciences' pedagogical model, which is "based on the integration and synthesis of knowledge to build critical thinking skills and to link discovery, creativity and engagement through laboratory and field-based investigations."

Research Program

Assessment of our research programs is conducted in association with annual performance reviews with individual faculty. Some of the metrics of this review are included in the faculty profiles presented previously in this report. We evaluate faculty based on their publication records (Figure 8), their citation metrics, and grant support for research (Figure 7). The citation rates of journal articles published by Watershed Science faculty is high with individual faculty averaging over 60 citations to their work each year. Watershed Sciences faculty have a mean h-factor of 12.4. These citation indices vary substantially among faculty members and are typically low for assistant professors. Our current assistant professors are all on very positive career trajectories, and this shows up in their rate of publication, the citations to their research outputs, and their ability to develop well-funded research programs in their area of specialization.

Outreach Programs

Water Quality Extension Program

Our water quality program conducts both evaluative and formative assessments. For existing programs, we track contacts and participants, including their ethnicity, gender, and location. We track website visits to determine which areas on our website are most often visited. We also review other web visit statistics to determine who accesses our site, key words they use and which pages are the common “entry points”. USU Extension tracks requests for fact sheets on their online publication page and we use this information as well to determine the usefulness and accessibility of the fact sheets we publish.

We determine the value of our existing programs in several ways. At formal workshops we ask that participants fill out a standard evaluation form on the value of the workshop and suggestions for changes. We compile this information electronically and use the feedback to modify and improve future programs. To determine the value of existing programs, we also conduct online surveys. For example, we last year we surveyed volunteers in our Lake Watch program, asking them for feedback on the existing program and ideas on strengthening the program. We also send follow up surveys every few years to the educators who participated in our Stream Side Science and other watershed education workshops.

Each year we also conduct a needs assessment with our many partners across the state and region. WE ask for feedback on our current programs and seek input on new and emerging areas that we should be addressing. Based on this feedback, we initiated a citizen monitoring program this year, will provide a workshop for watershed coordinators on outreach campaigns, and will be modifying future watershed fact sheets to better meet emerging needs. We conducted another survey of potential partners in this citizen monitoring program and are using this feedback, as well as input from focus groups and other meetings to determine the shape that this program will take. As this citizen monitoring program develops, we will track number of volunteers, number of sites monitored, as well as the value of the data for the agency funding the program.

We have conducted several in-depth evaluations of our youth education programs. In 2004 we used a social marketing approach with focus groups of educators and curriculum specialists to identify barriers to the use of a monitoring activities developed for schools. In response to this feedback, we developed a structured curriculum based on these monitoring activities, trained teachers in the use of this curriculum and then formally evaluated the knowledge gain in approximately 1000 ninth grade students who were taught these lessons. Before and after tests demonstrated significant increase in knowledge (Mesner and Walker, 2007).

Tiffany Kinder, a graduate student in WATS, has just completed an assessment of the value of a field day for 4th graders, looking at both increases in knowledge and interest in rivers and water quality. Kinder found that as little as an hour of high quality hands-on activities can significantly increase children’s knowledge of aquatic biology and pollution impacts, that the students retained this knowledge for at least 8 months and that additional activities in the classroom or additional field days improved the student’s retention and understanding. These findings are significant because so many water quality outreach programs in the state and nation rely on short term activities that are rarely assessed for real long term changes in knowledge or attitude. A paper of Kinder’s full results will be submitted to the Journal of Environmental Education this spring.

The Utah Master Naturalist Program

(<http://utahbotanicalcenter.org/htm/education/adults/utahmasternaturalist>)

The mission of the Utah Master Naturalist Program is to provide continuing educational experiences in Utah's diverse ecosystems to its citizens. Mark Larese-Casanova directs the program and has developed week-long modules in Utah Watersheds, Utah Deserts, and Utah Mountains. Each module consists of 40 hours of instruction which is delivered in a mix of classroom and field experiences. The program is targeted to professional environmental educators, K-12 teachers in the public schools, and volunteer naturalists.

Mark employs six assistants who have been trained to deliver the courses. A total of 79 people completed at least one the UMNP modules. The pool of participants was 76% female and 24% male, with an average age of 46 (range=22-72). In general, the participants were well educated, with 84% having at least a Bachelor's Degree. In addition, 18% and 2% had Master's and Doctorate Degrees, respectively. Seventeen participants, upon completing the Mountains module, became Certified Utah Master Naturalists in all three UMNP modules this year. One Watersheds class was sponsored by the Utah State Office of Education, and was taught exclusively to twelve K-12 teachers.

Mark has developed a rigorous assessment tool to measure the effectiveness of the Master Naturalist modules. Identical tests were administered at the start and end of the UMNP to assess participant learning. The average score on the pre-test and the post-test were 52% (st.dev.=18%) and 86% (st.dev.=10%), respectively, which indicated that the participants were learning and retaining the material taught in class. In addition, the participants who entered the UMNP with less knowledge (i.e., scored lowest on the pre-test) learned the most as indicated by the greatest percent change in score between the two tests. Therefore, the UMNP, on average, dramatically increased the knowledge of the participants, but also resulted in a more precise set of knowledge among the entire group of participants as evidenced by the decreased variability in post-test scores.

The UMNP participants completed evaluation forms at the end of the program. On average, participants strongly agreed that the UMNP has inspired me to learn more, was enjoyable, has inspired me to explore Utah's natural world more, has introduced me to more environmental education and resource management organizations in Utah, gave me a greater understanding of Utah's natural systems.

All K-12 teachers that participated in the Watersheds class produced lesson plans that will be used in their classroom during the following school year. Presumably, this increases the students' exposure to Utah's natural world, increasing awareness, knowledge, and understanding. The opportunity to offer the UMNP classes to teachers dramatically magnifies the reach of the program. For each teacher that participates in a class, the exposure of the program curricula increases at least twenty-fold.

The description and evaluation of this program is presented in the 2011 Journal of Extension publication "Assessment and Evaluation of the Utah Master Naturalist Program: Implications for Targeting Audiences" by Larese-Casanova and available on-line at: <http://www.ioe.org/ioe/2011october/rb2.php>

STRENGTHS, CHALLENGES, AND RECOMMENDATIONS

The strengths of Watershed Sciences departmental programs are many. The key strengths on which the success of the department depends include high quality research programs, a successful program of graduate education, a highly effective extension program in watershed management, and a very cohesive and supportive community of students, faculty and staff. In our research, education and extension we strive to address issues of relevance to the state of Utah, as well as national and global concerns. Below, we discuss our strengths and challenges in research, education and extension respectively. We then make specific recommendations for ways to enhance our current strengths and address the challenges we face.

Research Strengths & Productivity Challenges

Our research programs contribute to both theoretical and applied science in the areas of aquatic ecology, fluvial geomorphology, and watershed management. Faculty publish results of their research in widely read journals, compete successfully for research funds from core federal and state natural resource agencies, and work with these agencies to change the face of watershed management based on the results of our research programs. Our faculty are highly collaborative, working with scientists from the best research programs in North America and the world. These collaborations greatly enhance our approach to research. We view issues in natural resources from national perspectives and focus on ways to scale site-based research to larger geographic contexts. These collaborations also allow our graduate students to interact with scientists from around the world and gain better perspective on the issues important to our understanding of aquatic systems. The challenges to our research productivity currently fall in four areas.

First, we have relatively few state-funded faculty lines. The addition of another faculty line from state support, particularly in the area of fish ecology, would promote our ability to address issues of conservation of aquatic species, the impacts of non-native species into our aquatic environments, and the impacts of land use activities on the sustainability of aquatic resources. We currently increase the effective size of our activities by partnering well with critical agencies. The inclusion of faculty from the US Forest Service (Brett Roper), the US Bureau of Land Management (Scott Miller), and the USGS Fisheries and Wildlife Cooperative Research Unit (Phaedra Budy) program is vital to our ability to maintain vibrant programs in research and graduate education. We have not been as successful in partnering with state water agencies to expand our faculty assets. Developing a shared faculty position with the Utah Division of Water Quality or the USGS Water Science Center in Salt Lake City could open a wealth of opportunities for the Department to expand our activities and impacts in water sciences and address problems associated with water resources in our state.

In addition to fish ecology, expertise in aquatic toxicology would create a tremendous opportunity for growth in our research program and fill an important niche in our course offerings. We presently have research strengths in water quality but mostly in the area of nutrient management and eutrophication. Understanding and mitigating the effects of an ever-increasing diversity of environmental contaminants is a critical challenge facing natural resource managers and a potential growth area in our research and education programs. The environmental effects caused by the release of personal care products, pharmaceuticals, and wastewater associated with fossil fuel development emerge first within aquatic ecosystems. Opportunities for state and federal funding of research on the impacts of these types of toxicants is growing rapidly. Understanding the sources, movement within watersheds, and fates of these substances will be critical when planning to mitigate effects of the urbanization of wildlands and

the development of emerging energy industries. The University has little expertise in this area and the Department is well suited to capitalize on this need.

Riparian ecology and management is another area where additional faculty expertise could greatly expand our research and graduate education programs. Understanding linkages between land and water is critical for both water quality and biodiversity issues in our semi-arid region. We currently struggle to offer a riparian ecology course (WATS 5640) for our graduate students. Pooling resources with one or more terrestrially focused departments on campus might be one way to bring expertise in riparian systems to our campus.

The second challenge to our research productivity involves the administration of many small grants to address one large question or issue. Faculty excel at bringing partners together to solve management issues, but mechanisms to assist the linkage of funding could be helpful. Currently, many of these small grants are for one year. The time and effort associated with accounting, reporting, and writing proposals to maintain these research programs can be daunting and reduce efforts that should be focused on the research questions. As a department we have attempted to work with funding agencies to combine programs and extend time periods for grant operations, but we have not been very successful in these endeavors. The university has been helpful in allowing these small awards to be processed with reduced overhead rates. Recent changes in university funding policies may make these overhead reductions more difficult to obtain in the future. **Embracing a Cooperative Ecosystem Studies Unit type of funding model could help with the reporting and accounting tasks.** In addition, faculty need to be vigilant in seeking larger funding opportunities for their research programs and the department needs to be attentive in assisting faculty in these efforts.

The third issue potentially limiting our research productivity may be the way in which most of our research programs function. We have put a premium on graduate education and have been successful in this regard. This emphasis however may have reduced our ability to employ post-doctoral research associates to conduct research that is more synthetic and generalizable in nature. Faculty in our department continually debate the tradeoffs of graduate education versus other ways to address the research questions we are committed to answering. We currently have only 3 post-doctoral researchers working in our laboratories. The addition of more of these impressive young researchers would enliven our graduate programs in providing examples of successful transitions between graduate education and employment as faculty at other universities. Bringing recent PhDs into our programs from other institutions would also introduce novel ideas to our research family. We currently have no formal program to fund post-doctoral researchers in the department. New mechanisms to encourage faculty to bring these young researchers into our labs would be valuable.

Finally, we have little capacity in our current facilities within the NR, BNR and JQL buildings to accommodate new post-docs and/or visiting scholars. The simple lack of office and lab space could limit the capacity to grow should opportunities arise. Our facilities in the JQL are state of the art, but at capacity. We need to seek ways to increase laboratory space for faculty research programs.

Graduate Education Strengths & Challenges

Our program of graduate education is large, vibrant, and of high quality. Each faculty member typically supervises between 3 and 6 students. We credit our graduate students with carrying out the lion's share of research activities in the department. Graduates of our MS and PhD programs compete well for positions with research agencies, universities, and private firms. The ability of faculty to assist

agencies in their research needs provide a link for graduate students to gain employment with these agencies. One of our sources of pride is the number of graduates that currently work for our state water agencies. These former students do well in their chosen careers and frequently are promoted to positions of influence within the agencies. These former students are currently managing a large share of the public lands in the intermountain west. Our surveys with recent graduates indicate that the education they received through our programs serves them well in their efforts to solve problems and address the concerns of their state or federal agencies and to better serve the citizens of our country.

A potential weakness in our graduate program is the small number of PhD students who eventually go on to become faculty at other institutions. Our senior faculty have discussed this issue informally and no clear reason for this outcome is apparent, although there is a sense that academic positions are much less appealing to graduate students than they were 2-3 decades ago. Many of our graduating PhD students receive good offers of work from research agencies or NGOs. Our former PhD students who accept post-doctoral positions at other institutions have the best opportunity to gain a faculty position. Few of our PhD students seek out post-doctoral positions. Perhaps enhancing the number of post-doctoral research associates in our program and their interaction with graduates would provide role models needed to convince our students to pursue academic positions.

Another challenge in our graduate programs is that we are unable to offer many teaching assistantships to our graduates. There are many valuable teaching experiences our graduates can and do participate in, and our undergraduates and professional attendees of short courses and distance education benefit from and appreciate the expertise of our graduates in their teaching capacities. However, we receive little teaching assistantship support from the University largely due to our small undergraduate program. Thus, all of our graduate students are on research assistantships or fellowships. If we were able to offer funding for one to three teaching assistants per year, this would increase our capacity to bring on top students when they apply and other research assistantship funding is unavailable, keep supporting students who may require an extra semester or year to finish up, and provide valuable teaching experience to our MS and PhD students who we want to encourage to go on to rewarding careers in academia.

Undergraduate Strengths and Education Challenges

One of the largest current challenges in our department is to operate our program in fisheries education with limited faculty resources. The faculty who formerly taught several of the fisheries courses have moved into administrative positions (Luecke, Mesner, Hawkins) or have seen research interests change to non-fisheries areas (Wurtsbaugh). Presently, most of the courses taken by students in the BS in Fisheries and Aquatic Sciences degree program are taught by faculty who are federal cooperators and as such are paid by federal sources (Budy, Roper, Miller). These folks do an outstanding job in delivering the courses on fish diversity, fisheries management, freshwater invertebrates, and fisheries habitats. Such heavy reliance on non-E&G faculty for a key educational program can be problematic if the federal agencies need to modify their allocation of resources. We currently work effectively with the agencies to maintain teaching as a role for these faculty, but conflict over this issue has arisen in the past and will likely be part of future discussions. Finding sources to fund an E&G position in fisheries would solve this current issue and bolster our efforts to enhance the fisheries program at USU.

One of the biggest concerns for our undergraduate educational programs is the small number and only average quality of students who enter our BS degree programs. Discussions among faculty at retreats and meetings indicate that a large undergraduate degree program in either fisheries or watershed

sciences would not serve the interests of the university or the state in that the job market for students with undergraduate degrees is not strong. Although true, we need to maintain viable undergraduate programs for students whose ultimate career goals require a foundation in watershed or aquatic sciences. Approximately 30% of our undergraduates are accepted into graduate programs in aquatic sciences. In spite of their currently low numbers, students are able to form coherent cohorts and function as a close-knit community of scholars. If undergraduate numbers fall much below current levels, however, this sense of students being part of a greater whole may be reduced. We saw signs of this sentiment among our students after the recent college reorganization. A couple of efforts within the department could bolster both our number and the quality of undergraduates in the department. We do not have a coherent plan for undergraduate student recruitment in the department. We have relied on College efforts in the past and these have met with limited success. A recruitment plan is needed for both high school and transfer students that focuses on increasing the caliber and size of our applicant pool by targeting high achieving students both in-state and out-of-state. A greater percentage of recruiting higher achieving undergraduates could benefit both our educational and research programs. This type of recruitment effort could take better advantage of the integration of undergraduate activities with our research and extension programs in attracting good students. The creation of paid student interns could assist with recruitment of high quality students. The pursuit of funding for national research based intern programs, like the Research Experiences for Undergraduates at the National Science Foundation, could be part of this strategy. The Department could also make better use of the University's programs in undergraduate research, the honors program, and internship activity.

Extension Strengths & Challenges

Our extension programs are highly effective at enhancing the management of water quality in the state and at educating professionals who work in water resources, who educate our youth, and develop programs in environmental education. The extension faculty in Watershed Sciences (Mesner and Larese-Casanova) do an excellent job of working with state agencies to assist them in the implementation of their management programs. We work closely with the Division of Water Quality to assist them in their evaluation of best practices for watershed management. We work with regional EPA groups to assist the state of Utah in compliance issues, and our extension program provides essential links to NSF-funded projects in watershed instrumentation and information delivery. Our efforts in environmental education for youth and professional educators is greatly enhanced through the efforts of Mesner and Larese-Casanova to work with our state Office of Education to both shape the core curriculum taught in the public schools and to focus our efforts in teacher training on these core focus areas. All of our faculty also contribute to the continuing education of professionals in the natural resources fields by developing and delivering short courses for agency and private firm personnel. These short courses and distance-delivered courses have been very successful in assisting with state efforts to restore streams and rivers, monitor and analyze population dynamics of key species, and train professionals in environmental education.

These highly successful extension programs have large impacts on our state's water resources. We maintain these effects in spite of the very modest amount of funding from the university's extension program. USU Extension provides the department with 1.2 lines of faculty funding. These positions come with \$12,000 of operating costs. Most of our programming derives from competitive grants and from the income obtained from short course tuition fees. Funding an additional FTE in environmental education would allow us to take advantage of the recent focus on STEM education at the national level and assist us with our efforts to shape the K-12 educational programs in Utah. Increased levels of base

operating funds would reduce our reliance on external grants to keep these programs operating at a high level. We currently release employees in these areas when grant funding is not continuous. This lack of continuity limits the productivity of these extension programs. An increase in base funding for these programs would alleviate this current problem.

Recommendations

The primary challenges we face in terms of maintaining and strengthening our research, education and extension programs are linked to a small amount of base support from the University relative to our productivity as a department and the importance of these programs to the viability of watersheds and aquatic resources in the State. Although the department has been very successful in maintaining these programs with external grant funding and indirect costs returns, this is not the most secure foundation upon which to sustain vibrant programs and creates significant challenges in maintaining continuity. Our primary recommendation for addressing these challenges is to convince the University and our legislators that a relatively modest commitment in a higher base-level of support is an important priority for the University and the state of Utah. Specifically, we wish to secure base funding to cover:

1. 1-3 additional FTE faculty in areas of Fisheries (priority 1), Environmental Education and Extension (priority 2) and Aquatic Toxicology (priority 3)
2. Additional operating funds especially for programs in extension and research areas that are associated with state-endorsed goals and initiatives
3. One to two teaching assistantships per year
4. A longer-term (i.e. next 5 years) capital investment in new facilities (e.g. replacement and expansion of BNR/NR)

The first three items represent relatively modest, but long-term commitments from the University, which would help to secure and sustain our success while pursuing modest growth into areas where we are well positioned to be highly successful and effective. This investment would also free up discretionary funding from F&A overhead returns, which are currently used to cover our basic operation costs and maintenance of administrative and teaching costs. This discretionary funding could be redirected into further graduate student travel and finishing up funds. Finally, we are at or beyond capacity to accommodate further growth of our faculty, our undergraduate programs, our graduate programs and having the office space, lab facilities, and adequate teaching facilities to effectively compete with our peer institutions. A one-time investment to modernize, replace and expand our facilities to accommodate and sustain our programs into the future is long-overdue and sorely needed by both our department and the College of Natural Resources. Both the NR and BNR buildings have exceeded their design lifespan, are highly energy inefficient, and have some of the most uninspired, out-of-date and ineffective teaching and meeting facilities on campus.

Executive Summary

Departmental Highlights

- 1) The Department of Watershed Sciences has created a robust conceptual model of watershed sciences that fully integrates physical processes and ecology, and they have hired faculty and built a curriculum based on this model. The physical and ecological sides of watershed sciences are truly integrated in research and curriculum—they are not just assemblages of faculty and courses in the two broad areas.
- 2) The Department's faculty are productive and well-funded: with over \$3 million annually in contracts and grants, USU gets \$3 or more for each E&G dollar in the Department's budget.
- 3) The Department is very well-integrated with other departments inside and outside the College of Natural Resources, in research and in the education of their students.
- 4) The Department is very effectively integrated with federal cooperators, which enhances the research mission of the Department, increases the diversity of courses that may be offered, and which has created a wealth of opportunities for training graduate and undergraduate students.
- 5) The Department has six productive and enthusiastic junior faculty who very much like being at Utah State and have been hired in accordance with a very clear departmental vision.
- 6) For a departmental FTE of about eight E & G positions, the graduate program is large and strong, with the federal cooperators playing an important role in delivering coursework, advising, and mentoring. The graduate programs draw on strengths and resources of units all across campus, particularly the Ecology Center. Students are enthusiastic and appreciative of the ability and freedom to draw on these resources and opportunities. Students very much liked the Ecology Center Seminar and the fact they have a role in selecting speakers. The Master's degree program is producing graduates that are effective in roles concerning natural resource management within the state and throughout the western United States.
- 7) Students in the undergraduate programs uniformly thought they had found a home where the personal attention they received permitted them to succeed. They think that the quality of instruction is very high and, indeed, the Department won Utah State University's departmental teaching award in 2011. There are tremendous opportunities for hands-on research and experiences are available through the federal cooperators. Students were appreciative of the field-based experiences and the structure of courses within the Department emphasizing group work and presentations over formal exams.
- 8) The leadership of Chris Luecke over the last 10 years in all aspects of the Department has been exceptional. Students, faculty, and cooperators were all extremely grateful for his efforts.

Recommendations

- 1) We recommend continued, modest growth in number of E&G positions in the Department. Faculty have thoughtfully planned future hires in fisheries biology, riparian ecology, and aquatic toxicology, and hires in these areas are endorsed by the graduate students.
- 2) As resources permit, we recommend the addition of an extension position to support the Department's Outreach and Extension activities.
- 3) Facilities for the Department appear to be at, or near capacity. If future growth is realized, some planning will have to be undertaken with regard to facilities.
- 4) We applaud and support Utah State University's administrative initiatives to increase operating budgets and recommend continued growth, as possible, to support extension and outreach programs relative to the departmental mission with regard to the state.
- 5) We encourage the Department, with support from the College of Natural Resources and Utah State University development office, to develop a long-term plan for creating an endowment to help strengthen the doctoral programs and to support more postdoctoral positions.
- 6) Some of the larger enrollment classes in the Department have need of additional teaching support. We recommend the addition of teaching assistantships (TAs) to help this educational mission and to enhance graduate program teaching experience.

Background

The 2012 Regents' Review Committee for the Department of Watershed Science comprised Dr. Clifford N. Daum, Professor in the Department of Biology at the University of New Mexico; Dr. William E. Dietrich, Professor in the Department of Earth and Planetary Science at the University of California, Berkeley; and Dr. D. Richard Cutler, Professor and Head, Department of Mathematics and Statistics, Utah State University. The committee met with various individuals and groups of faculty and students in the Department of Watershed Sciences at Utah State University on March 5, 6 and 7, 2012 to discuss issues related to the Department. A copy of the review team itinerary is attached as Appendix A to this report. Prior to these meetings a self-study of the Department was provided to the committee members.

Introduction

The Watershed Sciences Department has created a well-funded, forward looking program that is distinct in emphasizing the linkages among physical, biological and chemical processes in a watershed context. It is the only named Watershed Sciences Department in the nation, and has committed itself through its undergraduate and graduate teaching to define watershed sciences as fundamentally interdisciplinary. Despite their modest FTE size (8 Education and

General FTE) they have brought together an effective and interacting faculty with strengths in aquatic ecology, biogeochemistry, climate, hydrology, geomorphology, and water resource management. Importantly, the Department has six excellent assistant professors who have added breadth, depth, and enthusiasm to the vision of a watershed science. Through shared appointments and, importantly, through close ties with Federal Cooperators, 16 faculty contribute to the program. The Department is actively reshaping its teaching program, it encourages its graduate students to explore resources across the entire campus, it is committed to its extension and outreach programs, and it strongly supports its young faculty.

Undergraduate Program

The undergraduate program in the Department of Watershed Sciences has offered Bachelor of Sciences degrees in Fisheries and Aquatic Sciences, Watershed and Earth Systems, and Physical Geography since 2003, when the Department was formed. The number of undergraduate majors has grown steadily over time, with increasing numbers of students in both the Fisheries and Aquatic Sciences and Watershed and Earth Sciences pathways. The first undergraduate students choosing the Physical Geography track are listed in academic year 2009-2010. Total undergraduate majors exceeded 60 students in academic year 2009-2010, the last year for which we were provided data.

The various tracks link well to the departmental mission of educating students in the methods and skills of watershed sciences, training the next generation of watershed scientists, and instilling interdisciplinary knowledge to inform water policy. The three tracks provide a good interdisciplinary science foundation with varying levels of course requirements in the three tracks. The Fisheries and Aquatic Sciences track has the most prescribed courses with lesser required credit hours in the Watershed and Earth Systems and Physical Geography tracks. Both the Fisheries and Aquatic Sciences and Watershed and Earth System students participate in capstone experiences as part of their undergraduate curriculum. Examples of the capstone courses were included in our review materials, and the depth, rigor, and breadth of these courses are exemplary.

The committee met with undergraduate students in the Department of Watersheds Sciences over lunch. The students came from the Fisheries and Aquatic Science and Water and Earth Sciences tracks within the Department. The students were highly complimentary of the curriculum, the faculty, and the program. Many of the students started their studies in much larger degree programs but found the smaller and more personalized attention in the Department to be much more to their liking. Student organizations and clubs are active within the Department, an interactive and engaged group of undergraduate majors is apparent, and the opportunity for research experiences—often linked to the federal collaborators in the Department—is excellent. The undergraduate students with whom we met voiced strong support for their educational program, the courses that they are offered, and the interactions with faculty and staff in the Department of Watershed Sciences.

Graduates of the undergraduate program are provided good opportunities to provide feedback on the courses and degree program that they are receiving. The department head engages with the faculty to review student input concerning courses and design improvements, where necessary. Exit interviews with graduating students are seen as the best input on ways to improve the undergraduate curricula. Input from the graduating seniors is then discussed at the annual faculty retreat and modifications implemented to better meet the needs of the undergraduate students. The students go on to graduate degree programs (~30%), state or federal employment (~40%), private consulting firms (~10%), and other types of employment (~20%). The committee found a healthy and well-functioning undergraduate degree program in the Department of Watershed Sciences.

Graduate Program

The Department of Watershed Sciences offers Master of Science (MS) and Doctor of Philosophy (PhD) degrees in Ecology, Fisheries Biology, and Watershed Sciences. The ecology degrees are linked with the well regarded Ecology Center at Utah State University. The degrees in Fisheries Biology focus upon the biology of fishes and fisheries management, the degrees in Watershed Sciences focus upon physical and chemical changes to watershed and human influences on these changes, and the degrees in Ecology focus upon topic areas from biophysical ecology to landscape ecology. The number of graduate students in the Department of Watershed Sciences has been stable for the past six years with enrollment between 41—49 graduate students per year. With full-time equivalent faculty of about eight, this reflects a healthy graduate program. The proportion of PhD students over the six years of record provided to the review team ranges from 35%—49% with more PhD students in the Ecology and Watershed Science tracks than in the Fisheries Biology track. Graduate degrees awarded over the past six years have ranged from 9—20 degrees per year with about 10% percent of the degrees being doctoral degrees.

The review committee met with about a dozen of the graduate students. The students represented a good cross section of the graduate program in the Department of Watershed Sciences with research in fisheries biology, ecology, and watershed sciences. The feedback that the review committee received from the graduate students was overwhelmingly positive. The graduate students were generally satisfied with the curriculum, advisement, and support from the Department. Areas that the graduate students were particularly pleased with included the assistance the Department provides in interfacing with the School of Graduate Studies, the seminar offerings (Ecology Center, Spring Runoff Symposium, and WATS Departmental Seminar), the short topical courses (“Espresso Courses”), and the social interactions between students, staff, and faculty. The review committee discussed with the graduate students the areas of faculty expertise where they would like to see additions made if future resources allow faculty growth in the Department to occur. The three areas that the graduate students highlighted (fisheries biology/ecology, riparian ecology, and ecotoxicology) match closely the areas identified by the faculty. The one area where the students expressed an interest in developing better opportunities was in the area of teaching through teaching assistantships. Many of the graduate students would like to add some additional teaching experience to their

resume before graduation. The graduate students also were highly complimentary of their ability to move through the university to get classes, research experiences, and advisement outside the Department of Watershed Sciences and the College of Natural Resources. In summary, the graduate students with whom we met were articulate, thoughtful, and appreciate of the graduate education they were receiving with the Department.

Research

The Department has a very active research profile into which graduate students and federal collaborators are thoroughly integrated, and many faculty in other units across campus are involved as collaborators. Given the small size of the department, the research interests of the faculty are extraordinarily broad, covering a wide swathe of aquatic ecology, limnology, fisheries, hydrology, geomorphology, biogeochemistry and climate modeling. The Department has excelled at obtaining research funding to support research and graduate students, consistently obtaining over \$2 million in annual contracts and grants, averaging \$3.5 million per year over the last six years and over \$5 million in each of the last two years. This represents a return for USU of \$3—\$5 for each \$1 of E&G funding for the Department. The Department's funding is extremely diversified, coming from more than 20 different agencies and foundations, including the National Science Foundation, the US Geological Survey, the US Environmental Protection Agency, the National Park Service, the National Oceanic and Atmospheric Administration, and six state agencies. With this funding, and scholarships from the Quinney Foundation, the Department has been able to support a relatively large (given the size of the Department) graduate program, as described above.

Consistent with their success in obtaining research funding, faculty in the Department of Watershed Sciences are productive in terms of research publications, with articles appearing in top journals and high citation rates, particularly for senior faculty. In the six years from 2005 to 2011, departmental faculty have published 180 papers at an average of 2.3 per faculty member per year. Excluding faculty whose primary appointments are in administration and extension, the average number of publications per faculty member per year is 3 or a little higher. Faculty publications are well-cited. For example, in 2011 there were more than 900 citations of publications by departmental faculty. Four senior faculty have H-indices of 20 or higher and in excess of 1,000 citations each.

The high citation rates and extensive funding are indicators of a department that is productive and nationally recognized for the quality of scholarship produced by its faculty. The Department has built an interesting—perhaps unique—model of watershed sciences and the review committee was impressed by the recent hires of tenure track faculty to support the research aspect of the model. Proposed future hires in fisheries biology, riparian ecology, and aquatic toxicology have been well thought out in terms of where they fit with the research and educational missions of the Department.

Research Units and Centers

Three centers and two units contribute substantively to the strengths and success of the Department of Watershed Sciences. The centers and units integrate well with the mission of the Department and provide both research and education opportunities for the undergraduate and graduate students in the program. The centers and units build collaboration among the faculty, bring national and sometimes international recognition to the university, support both undergraduate and graduate research, and provide visible focus to key areas of research on the Utah State University campus.

The three centers are the BLM/USU National Aquatic Monitoring Center, the Western Center for Monitoring and Assessment of Freshwater Ecosystems, and the Ecology Center. The National Aquatic Monitoring Center (NAMC) is referred to as the BUGLAB because the primary focus of the center is the processing of aquatic invertebrates from across the United States for the development of regional predictive models of biological condition of streams and rivers. The center is a recognized national asset that also provides a major source of employment for both graduate students and undergraduate students at Utah State. The Western Center for Monitoring and Assessment of Freshwater Ecosystems, whose mission is the development and application of scientifically sound methods for monitoring and assessing the condition of aquatic ecosystems, has a synergistic relationship with NAMC. The databases available through the center are of national and international significance for carrying out aquatic ecosystem bioassessment, the development of predictive models, and the running of predictive models for watershed assessments.

The Ecology Center has been an umbrella center for ecology research throughout the university with a history of strong and progressive leadership since inception in 1967. The new director, Dr. Nancy Huntly, continues this strong tradition for the Ecology Center with co-funding of 18 faculty lines, serving as a cost center for ecology research on campus, coordinating and facilitating the ninety plus graduate students in ecology campus-wide, and developing and delivering innovative seminars and education within the overall field of ecology. These three centers are an important part of the recognition that the Department of Watershed Sciences receives nationally and internationally.

Two federal agency units contribute to both the research and education mission of the Department of Watershed Sciences. These units are the Utah Fisheries and Wildlife Cooperative Research Unit of the US Geological Survey and the Fish and Aquatic Ecology Research Unit of the USDA Forest Service. The USGS Cooperative Research Unit conducts research on natural resource issues, educates students, and provides technical services to cooperators. The committee was particularly impressed with the crucial role that the coop unit plays in fisheries education within the Department of Watershed Sciences. Much of the fisheries curriculum in the Department is delivered through this collaboration. The Fish and Aquatic Ecology Unit of the US Forest Service has a strong relationship with the Department that includes continuing education, dissemination of research technology, and improved methodology to assess in-

stream and riparian habitat in western watersheds. The role of federal cooperators in both the education and research mission of the Department is vital, and the department head throughout most of the history of the Department (Chris Luecke) has done an exceptional job of fostering this partnership with the federal agencies at the national level.

Extension

The Department of Watershed Sciences is engaged in Extension and Outreach activities appropriate to its mission and role within the state. Many faculty carry out such activities informally, for example, working with state scientists and administrators in the Utah Division of Water Quality. Two major outreach efforts housed in, and supported by, the Department are the *Water Quality Extension Program*, directed by Nancy Mesner, and the *Utah Master Naturalist Program*, directed by Mark Larese-Casanova.

The Water Quality Extension Program is designed to help people understand the links between their everyday activities, land uses, and water quality. The educational part of the program involves working with the Utah State Office of Education to develop “hands-on” curricula and lesson plans for teachers that are consistent with the Utah Core and meet national environmental education standards. The extension aspect of this program involves working with appropriate state and federal agencies to identify needs and develop materials to help watershed managers.

The Master Naturalist Program is designed to provide an educational experience to Utah residents concerning the state’s diverse ecosystems. Mark Larese-Casanova has developed a set of modules involving a mixture of classroom and field experiences that he, and six trained assistants, deliver to professional educators (including K—12 teachers) and other interested Utah residents. In the past two years approximately 80 people have completed at least one of the modules.

Support for the Department’s extension activities comes in the form of 1.2 faculty lines from USU Extension, operating funds attached to those faculty lines, and a significant sum from external, competitive grants. These extension programs have been very successful but additional support will be needed in order to maintain and expand these programs. The Department is currently negotiating with USU Extension for a new position in Environmental Education and Extension. The review committee commends the Department for its outreach activities, which are totally consonant with the Department’s mission, and we note that graduates from the Department’s MS program often go on to serve as watershed managers and in related roles in the state and region. The review committee supports the Department’s request for an additional extension position to better carry out and extend its outreach activities.

Faculty

Of the 16 faculty affiliated with the Watershed Sciences Department only 6 hold full FTE in the Department. The Department has effectively used shared appointments and Federal Cooperators to create the necessary teaching and research breadth for such an interdisciplinary topic as watershed sciences. These cooperators contribute to the teaching and graduate education, provide research and practical work opportunities for undergraduates, and maintain a focus on key environmental issues. Hence, the cooperators are not simply housed in the Department. Rather they are active, contributing members that contribute significantly to the vitality of the Department. Overall, the faculty are productive (2.3 publications per year), well supported, and committed to teaching and to their stated vision of promoting “stewardship of the environment”.

We applaud the University and the Department in making the six recent assistant professor appointments. These young faculty bring expertise in climate modeling, wetlands, ecogeomorphology, watershed hydrology and geomorphology, water resource management and modeling, and environmental education—all vital components of a watershed science. They have created new research programs. We found these faculty to be highly engaged in teaching, including the development of new courses and course structures (e.g. “espresso courses” with a workshop like format). The faculty expressed appreciation for the freedom to pursue their research, although they acknowledged the expectation that some component of their studies should be done in Utah. Some faculty found the startup funds small and expressed frustration over the lack of graduate student support, including insufficient teaching assistantships. Nonetheless, these young faculty expressed great appreciation for the Department.

Of the 16 affiliated faculty (including Federal Cooperators), 5 are women, including two of the assistant professors. This is a relatively good record. As is common in departments, but particularly important in small ones, the senior faculty have taken up administrative duties. Hawkins is Chair, Luecke is Interim Dean, Mesner is Associate Dean, and Schmidt is Chief of the USGS Grand Canyon Monitoring and Research Center. These are important duties, but they lead to less teaching commitment, less research or both- and inevitably this puts pressure on the other faculty. The Department recommends future appointments in fisheries biology, riparian ecology, and aquatic toxicology. Given the popularity of the Fisheries and Aquatic Sciences undergraduate degree, the proposed appointment fields seem appropriate, and given the size of the Department, and the commitment of senior faculty to administrative duties, it is necessary.

Appendix A Review Committee Schedule

WATS Departmental Review

Date	Time	Person or Group	Room
5-Mar	Noon	Lunch with Committee (Hawkins)	
	1:30	Charles Hawkins, Department Head	NR 210C
	2:00	Faculty group: 10 m presentations and 30 min discussion	NR 204
	3:00	Meet individually with faculty	x
	4:30	Graduate students	x
	5:30	Break	x
	6:30	Dinner and social at Chuck Hawkins' house	
6-Mar	8:00	Chris Luecke, Interim Dean of CNR	NR 108
	8:30	Mark McLellan, VP for Research	
	9:00	Nancy Huntly, Director of Ecology Center	NR 314
	9:30	Meet with Federal collaborators (Budy, Roper, Miller)	NR 202
	10:30	State Collaborators UDWR, UDWQ, State Lands (Walker, Ostermiller, Ault)	x
	Noon	Lunch with undergraduates	x
	1:30	Research Center Directors (Schmidt, Miller, Hawkins)	x
	2:00	Undergraduate Research Mentors	x
	2:30	Open time	x
	3:00	Raymond Coward, Provost Office	Old Main, 114
	6:00	Dinner with committee on their own	
7-Mar	8:00	Charles Hawkins, WATS Department head answers questions	NR 210C
	9:00	Report writing	
	Noon	Debriefing and lunch (Hawkins and Luecke)	
	1:00	Leave for airport	