

The Department of Watershed Sciences NWCCU Accreditation Self-Study

I. Summary

Description of the Department

The Department of Watershed Sciences was created during the reorganization of the College of Natural Resources in July of 2002. The original name of the department was Aquatic, Watershed, and Earth Resources. The name changed to the Department of Watershed Sciences in July of 2006. The department consists of seven E&G faculty, plus one faculty (Mesner) funded mainly from the university extension program and one faculty (Kasahara) funded mostly from the Agricultural Experiment Station. Two additional faculty (Van Miegroet and Gillies) have half-time appointments in Watershed Sciences and half-time appointments in other academic units.

Watershed science is the study of the physical, chemical, and biological processes associated with the movement of water across the landscape. Clean and adequate water supplies are an essential element of human societies. Understanding the interaction among water, earth materials, and plants and animals is essential to the management of natural, agricultural, and urban ecosystems. The Department of Watershed Sciences offers comprehensive educational opportunities for undergraduates and graduate students interested in fisheries science, aquatic ecology, the understanding of our watershed ecosystems. Departmental faculty provide expertise in fish biology, the management and conservation of aquatic ecosystems, and analysis of the water cycle. The department offers two undergraduate degree programs, the BS in Fisheries and Aquatic Sciences, and the BS in Watershed and Earth Resources. Graduate degree programs include MS and PhD degrees in Fisheries Biology, Watershed Science, and Ecology. Our degree programs help students learn how water links the physical, biological, and geographic aspects of watersheds that are necessary to understand and manage water supply, water quality, and ecosystem health. Graduates of these degree programs become scientists and managers for natural resource agencies, professionals with consulting and nonprofit environmental firms, and teachers and researchers at major universities.

The Fisheries program in our department was ranked third in the nation by the Faculty Scholarly Productivity Index. The inaugural FSP index report, released in January 2007 and based on data from 2005, rates faculty members' scholarly output

including the number of books and journal articles published and awards received. Our department was tied for third place in fisheries science and management behind number one University of Washington and number two University of Minnesota. Developed by Academic Analytics, a company partially owned by the State University of New York at Stony Brook, the FSP index ranks 7,294 individual doctoral programs in 104 disciplines at 354 institutions. The hard work and dedication of Watershed Sciences faculty and graduate students to improve our nation's aquatic ecosystems is rewarded in this distinction.

The Department of Watershed Sciences collaborates extensively with entities on and off campus. The Department is an integral part of the USU Water Initiative. Three federal research groups are housed within our department. The Utah Cooperative Fisheries and Wildlife Research Unit (USGS), the National Aquatic Monitoring Center (US-BLM), and the Fish and Aquatic Ecology Unit (US-FS) link the dominant federal and state natural resources agencies with our department and provide research opportunities to faculty and employment opportunities to students.

Our extension program in Water Quality has been very successful in having an impact on our state water quality agencies, in helping communities comply with environmental regulations, and in shaping the K-12 educational systems through teacher training and curriculum development. The Water Quality Extension Team in the Watershed Sciences Department has been implementing a series of water quality monitoring stations in the Bear River Watershed to test the effects of improving agricultural practices on water quality. Real time information from these stations is displayed in the Bear River Watershed Information web site in a program jointly funded by the National Science Foundation, the Environmental Protection Agency, and the US Department of Agriculture. The Watershed Sciences extension program has also been instrumental in helping communities in the state come into compliance with US-EPA regulations on sewage and storm water management. Two of the extension personnel in the department were awarded special commendation by Governor Olene Walker in 2004 for their work in the development of "Stream Side Science", a new watershed curriculum for all 9th grade students in the state.

B. Analysis and Assessment

Undergraduate majors in the Department of Watershed Sciences have ranged from 23 to 33 students since the inception of the department in 2002. These students are split equally into the FAS and WES degree programs. The number of graduate students in our department varies between 40 and 60 students. We recruit graduate students from a national pool. The strong research reputation of our faculty, coupled with excellent fellowship opportunities provided by the Quinney Foundation allows us to recruit some of the best graduate applicants in the country.

Students earning BS degrees from the Department of Watershed Sciences find employment with natural resource agencies, consulting firms or enter graduate programs in aquatic sciences. Since 2002 almost half of these BS graduates went on to continue their education in graduate schools. Another 30% were employed by natural resources agencies. Students graduating from the Department of Watershed Sciences with a Masters degree found employment with governmental natural resource agencies, continued their education in PhD programs, or became employed by private consulting firms or non-governmental agencies. The nine PhD students that finished their degrees since 2002 are continuing in their careers as post-doctoral research associates in academic institutions, employed as faculty at an academic institution, work for governmental agencies or private consulting firms. Over 80% of the students attaining the BS degree and over 95% of students completing graduate degrees were still working in the profession.

C. Challenges and Recommendations

Recent changes in our profession have made it clear that a graduate degree is the entry into professions of fisheries and watershed science. Our department has a number of objectives that need to be addressed to meet the challenge of the changing educational needs of the profession. The Watershed Sciences Department is placing more emphasis on graduate educational programs by emphasizing the PhD program, by recruiting from a national pool of applicants for graduate degrees, and by increasing research activities to fund the graduate program.

The largest deficiency of our current programs has been the relatively low number of graduates who

have entered the academy. We have done an excellent job in providing the next generation of agency leaders, but have generally failed in providing similar numbers of future academic leaders. Current efforts to enhance the number of PhD students in our program will help us address this issue. We also need to increase the number of post-doctoral researchers that work in our research laboratories. We have also made a commitment to increase the number of MS students in our department by becoming more involved in the Master of Natural Resources degree.

The research and extension programs in the Department of Watershed Sciences are among the best at Utah State University and compare favorably with similar programs across the country. The publication rate of our faculty is high, rates of external funding for research and extension is extensive, and our outreach programs reach natural resource professionals, community leaders, individual citizens, and K-12 teachers and students. Even with these successes, we have established goals to accomplish in the next five years. The Department of Watershed Sciences does not have strong contacts with the Utah Division of Water Quality. We hope to establish an internship program where our graduate students would be funded by the agency and then our graduates would have opportunities to begin full time employment. The Department also seeks additional opportunities to form closer alliances with the US Geological Survey. Faculty members in our department have been working with Dr. Naftz of the USGS on research projects concerning water quality and toxicology of organisms living in the Great Salt Lake. The Watershed Sciences Department also has the opportunity to become involved with research groups proposing to host a National Ecological Observation Network site (NSF-NEON) in northern Utah, and an intermountain hydrological observatory under the direction of NSF and CUAHSI. Our challenge is to encourage faculty to become involved in these activities that will likely define much of our nation's environmental research during the coming decades.

One of our largest challenges will be to maintain our research funding in this era of shrinking federal budgets. Without continued funding at current levels, the research and graduate education program in the department will become greatly diminished. Even our operative funds will largely disappear if funding rates drop precipitously.

Self Study

A. Overview of the Department

Watershed science is the study of the physical, chemical, and biological processes associated with the movement of water across the landscape. Clean and adequate water supplies are an essential element of human societies. Understanding the interaction among water, earth materials, and biota is essential to the management of wildland, agricultural, and urban ecosystems.

Watershed scientists work in government land and water management and research agencies, non-governmental organizations, environmental and engineering consulting firms, and private companies that manage large tracts of land. Watershed scientists work throughout the United States, and the developed and developing world in the tasks of understanding, managing, and restoring water supplies, water quality, and ecosystem health.

Watershed scientists typically concentrate in either physical, chemical, or biological processes but understand the broader natural and social science context within which water-related processes occur and water is managed.”

The mission of the Watershed Sciences Department 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.

Our teaching mission is accomplished through the delivery of two undergraduate degree programs, three Masters of Science degree offerings, and three PhD degrees. We presently have approximately 30 undergraduate majors and 50 graduate students split about equally between MS and PhD students. We have a very active research program with approximately \$4M in ongoing external research funds. The Department has a nationally recognized extension program that focuses on providing assistance to state, county, and city governments, and to agriculturalists in their efforts to improve water quality. Our extension program also provides outreach education to middle and high school teachers in the form of teacher training workshops, to K-12 students in terms of field trip support and activities, and support to the Utah Office of Education in terms of curriculum development.

Departmental Collaborations

The Department of Watershed Sciences collaborates extensively with entities on and off campus. The Department is an integral part of the USU Water Initiative. One of our faculty, Dr. Jack Schmidt, is presently Associate Director. Watershed Sciences faculty and students help organize and participate fully in the cyber seminar series. The Watershed Initiative was established in 2002 from a codicil signed by the Colleges of Natural Resources, Engineering, Agriculture and Science. These collaborations have grown to include 20 of the 45 departments on campus. Here are some of our cross campus connections.

Three federal research groups are housed within our department. The Utah Cooperative Fisheries and Wildlife Research Unit coordinates interactions between our state fish and game agency and the Department's research programs. The National Aquatic Monitoring Center is a cooperative venture between Utah State University and the U.S. Bureau of Land Management. Dr. Mark Vinson is the director of this center and is on the faculty of the Watershed Sciences Department. The Fish and Aquatic Ecology Unit of the US Forest Service is located in our Department. Dr. Brett Roper is acting director of the unit and a member of our faculty. These three research programs link the dominant federal natural resources agencies with our department and provide research opportunities to faculty and employment opportunities to students.

B. Undergraduate and Graduate Academic Programs

The Department of Watershed Sciences offers comprehensive educational opportunities for undergraduate students in hydrology, geomorphology, biogeochemistry, water quality, watershed management, fisheries, aquatic ecology, remote sensing, and geographic modeling. Faculty members provide expertise in fisheries, the hydrologic cycle, conservation biology, restoration and management of aquatic and riparian ecosystems, and the remote sensing and geographic analysis of the earth's landcovers. Graduates of departmental programs become scientists and managers for natural resource agencies, professionals with consulting and nonprofit environmental firms, and teachers and researchers at major universities.

The department offers two undergraduate degrees. 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. Students attaining the BS in Fisheries and Aquatic Sciences will develop strong quantitative skills in animal population biology, assessment of aquatic habitats, and an understanding of ecological understanding of aquatic organisms. Graduates will be well-prepared to take positions in state and federal natural resource agencies; to enter graduate programs in the biophysical and natural resource disciplines; and to take positions working with consulting firms, nongovernmental organizations, and earth science industries.

Undergraduate majors in the Department of Watershed Sciences have ranged from 23 to 33 students since the inception of the department in 2002 (Figure 1). These students are split equally into the FAS and WES degree programs.

These low numbers of students derive in part from the tendency of our students to not declare these majors until their junior year. This tendency comes in part from the large number of students who transfer into our undergraduate degree programs from other Utah institutions, and from other USU students who switch to our majors after beginning in other majors in the Colleges of Natural Resources, Engineering, and Science. We award bachelors degrees to an average of 13 students per year, indicating that approximately half of our undergraduate majors finish each year (Figure 2). No discernable trends in enrollments or majors are evident in these data. The low numbers of students in these degree programs make year to year comparisons difficult.

Over 85% of the students are classified as full time students. Many of these students work many hours in off campus jobs and several are married with small children. Women comprise 25% of the students. Minority and international students make up a very small proportion of our enrollment (Table 1).

Fig. 1 Undergraduate Majors

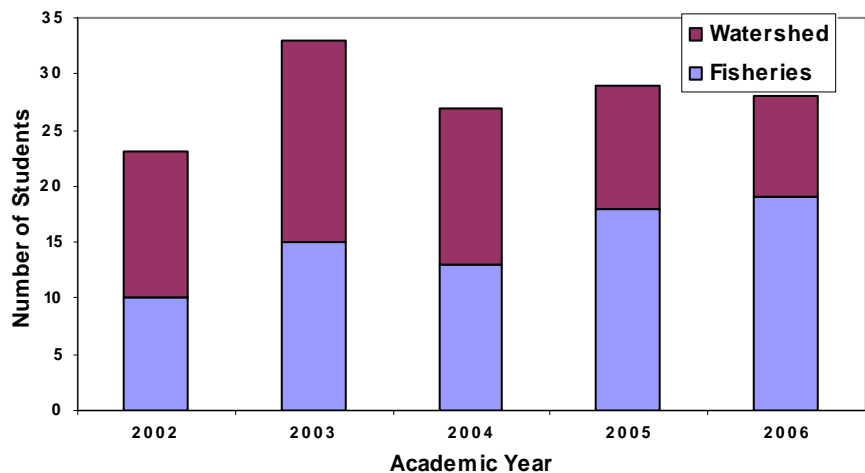


Fig. 2 Undergraduate Degrees Awarded (* denotes fall semester only)

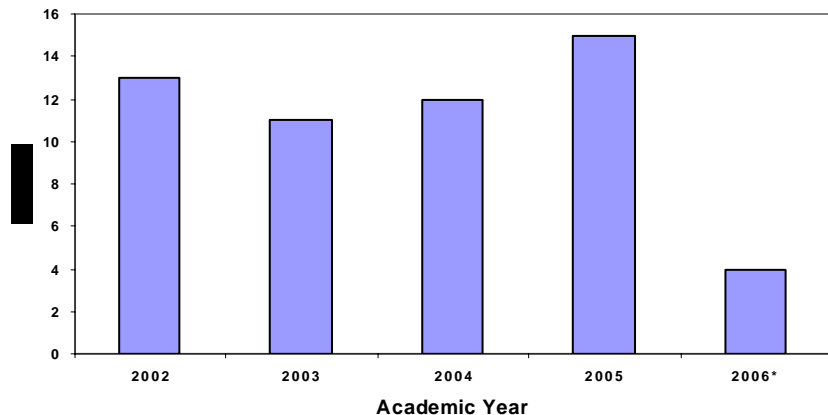


Table 1 Department of Watershed Sciences

COLLEGE OF NATURAL RESOURCES DEPARTMENT OF WATERSHED SCIENCES					
MAJORS (FALL SEMESTER)					
Undergraduate Headcount	2002	2003	2004	2005	2006
Fisheries & Aquatic Sciences		5	11	9	16
Fisheries & Wildlife	10	10	2	9	3
Watershed & Earth Systems		8	12	10	6
Watershed Science	13	8	1		
PreWatershed Science		2	1		
Total Undergraduate	23	33	27	28	25
Graduate Headcount					
Ecology	29	28	31	28	25
Fisheries Biology	8	10	9	10	6
Watershed Science	12	16	14	11	9
Total Graduate	49	54	54	49	40
TOTAL MAJORS	72	87	81	77	65
Demographics					
Undergraduate					
% Full-time	75.0%	81.8%	88.9%	92.9%	68.0%
% Female	40.0%	21.2%	22.2%	21.4%	16.0%
% Minority	0.0%	0.0%	0.0%	0.0%	4.0%
% International	0.0%	3.0%	3.7%	7.1%	0.0%
Graduate					
% Full-time	67.3%	25.9%	77.8%	73.5%	50.0%
% Female	36.7%	35.2%	33.3%	28.6%	35.0%
% Minority	6.1%	3.7%	3.7%	2.0%	0.0%
% International	6.1%	5.6%	5.6%	22.4%	12.5%
STUDENT CREDIT HOURS (FALL SEMESTER)					
Remedial					
1000	132	210	109	72	12
2000					
3000	88	132	89	109	85
4000	289	249	265	261	229
5000	37	49	72	38	62
6000	238	217	273	251	219
7000	46	72	111	112	49
TOTAL STUDENT CREDIT HOURS	830	929	919	843	656
DEGREES (ACADEMIC YEAR)					
	2001-02	2002-03	2003-04	2004-05	2005-06
Certificate					
Associate					
Bachelor		13	11	12	15
Post Bachelor					
Masters	N/A*	4	6	8	5
Post Masters (Specialist)					
Doctoral			1	4	1
TOTAL DEGREES	0	17	18	24	21
FIRST-YEAR RETENTION RATE (FALL COHORT)					
	2000	2001	2002	2003	2004
			100.0%		50.0%
SIX-YEAR GRADUATION RATE (FALL COHORT)					
	1995	1996	1997	1998	1999
FULL-TIME FACULTY					
	2002	2003	2004	2005	2006
Headcount	10	10	10	10	
Demographics					
% Female	10.0%	10.0%	10.0%	20.0%	
% Minority	0.0%	0.0%	0.0%	0.0%	
Rank					
	2002	2003	2004	2005	2006
Professor	2	2	4	4	
Associate Professor	4	4	2	2	
Assistant Professor	4	4	4	4	
Instructor					
Lecturer					
Other					
PERCENT OF FACULTY WITH TERMINAL DEGREES**					
	2002	2003	2004	2005	2006
	100.0%	100.0%	100.0%	100.0%	

*Reorganized in 2002

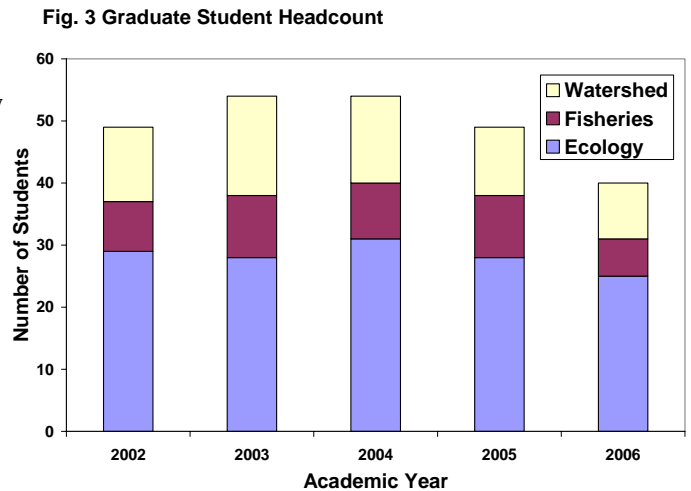
** Analysis based on full-time instructional faculty.

Graduate Academic Program

The Department of Watershed Sciences offers MS and PhD degrees in Fisheries Biology, Watershed Science, and Ecology. In these degree programs students combine coursework and research in the hydrologic sciences, aquatic ecology, and remote sensing into an integrative aquatic sciences program. Our graduate students gain research experience and expertise in watershed analysis and restoration, remote sensing and GIS, and fisheries and conservation biology. Our degree programs prepare students for careers in natural resources management and natural systems research.

The number of graduate students in our department varies between 40 and 60 students (Figure 3). The department works to integrate students in different degree programs by mixing office and lab space for students across department facilities. This integration provides for a sense of departmental cohesion among graduate students and creates a pleasant work environment for these young professionals.

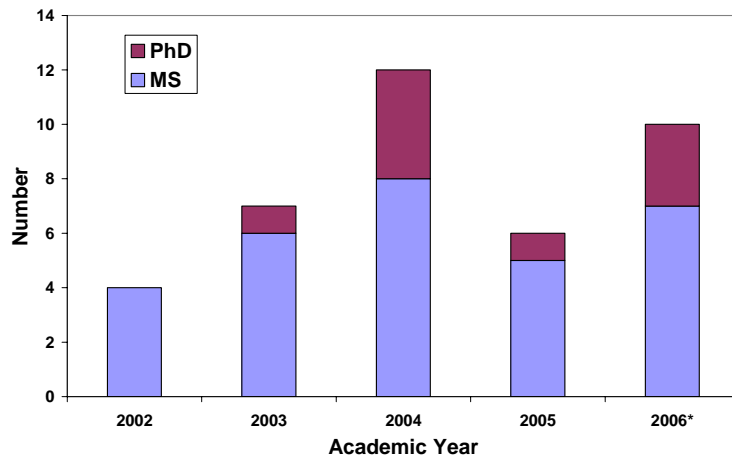
We recruit graduate students from a national pool. The strong research reputation of our faculty, coupled with excellent fellowship opportunities provided by the Quinney Foundation allows us to recruit some of the best graduate applicants in the country. Over 60% of our graduate students are from states other than Utah or Idaho, and approximately 15% are international students. Approximately one third of the graduate students are women. Less than 5% of the graduate students belong to minority groups (Table 1).



The Department of Watershed Sciences has awarded 5-12 graduate degrees per year (Figure 4). Approximately one third of these are doctoral degrees. Graduate students typically take 3 years to complete the MS and 5 years to

complete the PhD degree. We have made an effort to increase the number of PhD students in our programs during the past four years. Our PhD graduation rates have increased in response to this effort. The combined number of MS and PhD students in our programs will not likely increase in that most faculty now have 4-6 graduate students working on these research-based degrees. In 2005 our College began promoting a professional MS degree (Masters of Natural Resources) that has the potential to grow substantially during the next few years. This non-research degree can be completed in 1-2 years with some of the requirements being delivered via distance education modalities.

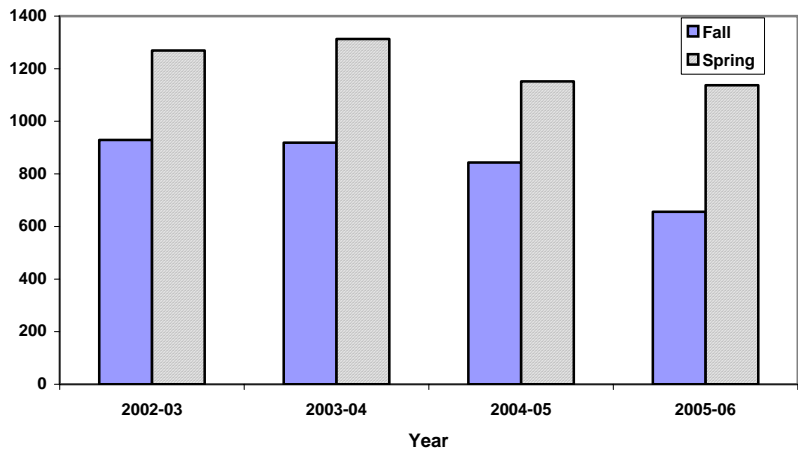
Fig. 4 Graduate Degrees Awarded
(* denotes fall semester only)



Student Credit Hours

Student credit hours taught by members of our department have declined slightly since 2002 (Figure 5). In the 2004-05 and 2005-06 academic years, our department solved budget cut issues by reducing expenses related to teaching two 1000-level general education classes (Table 1). The results of these budget cuts explain most of the declines in our student credit hours for those years. The elimination of these budget cuts has allowed us to teach these again, beginning in fall semester of 2006. A large portion of the student credit hours are taught at the 4000 and 6000 level of classes indicating the high number of transfer students that enter our undergraduate majors, and the large number of MS and PhD students in our graduate programs.

Fig. 5 Watershed Sciences Student Credit Hours



Analysis and Assessment

Assessment of undergraduate programs in AWER consists of four measures of student success. Students are surveyed at the end of their senior year to determine how well they felt the degree programs met their needs. Results of these extensive exit questionnaires given in June are reported to the faculty and discussed during the fall retreat. The department head also conducts individual interviews with graduating seniors to assess the quality and value of the degree programs. Nine months after graduation, a placement survey is delivered to graduates to assess the employment results of the most recent class. In addition to student responses, a system of peer teaching evaluation provides the faculty with insights into the strengths and weaknesses of specific courses and the integration of the courses into degree programs. Results of each of these evaluations are used to modify the curriculum, make teaching assignments, and proportion resources to the various courses taught by faculty in the department.

Specific learning objectives are associated with our degree programs. These programs highlight quantitative analysis of environmental data. Students become facile in computer applications, learn the basics of inferential statistics, gain exposure to remote sensing and geographic information system technology, and gain the writing skills necessary to convey their analytical abilities. Field methodology and data collection is emphasized. Graduates of these programs are able to use these tools to analyze and solve environmental problems. Our undergraduate degree programs ensure that students learn and understand the relevant issues in environmental science as applied to the conservation of aquatic resources and the management of aquatic biota.

Both degree programs have required capstone experiences that force students to become involved in the analysis of an environmental problem. Students collect, analyze and synthesize data and propose solutions to a given set of problems. Writing skills are emphasized. How the students fare in this capstone experience depends on the degree to which previous courses prepared them for these types of real life issues.

1. Program Learning Objectives

The department developed 17 learning objectives associated with our two undergraduate degree programs. The first set of learning objectives listed below represent skills and proficiencies needed by all students in our program:

The first set of learning objectives represent general skills needed by all Watershed Sciences undergraduate students.

1. Gain proficiency in spreadsheet analysis
2. Statistical competence in ANOVA, regression
3. Competence in GIS using ArcView, AarGIS

4. *Writing competence for science applications*
5. *Oral communication skills*
6. *Understanding of biogeochemical cycling of Carbon, Nitrogen, Phosphorous*
7. *Analysis of services ecosystems provide*
8. *Assessment of human impacts on earth systems*

The second set of learning objectives are specific to the Watershed and Earth Systems BS degree.

9. *Understanding of hydraulics and sediment transport in streams*
10. *Make measurements of stream discharge, hydraulic forces, channel features*
11. *Analysis of environmental conditions for remotely sensed data*

The third set of learning objectives relate to the curriculum associated with the Fisheries and Aquatic Sciences BS degree.

12. *Understanding the biology of aquatic organisms*
13. *Evaluate specific habitat requirements of aquatic organisms*
14. *Analyze and simulate population dynamics*
15. *Assess human impacts on biodiversity*
16. *Make measurements of fish abundance, biomass, growth*
17. *Make measurements of algal and invertebrate abundance*

The Department of Watershed Sciences surveys undergraduate students each year to assess the degree to which the curriculum allows students to achieve the learning objectives. These surveys have indicated that we were accomplishing our goals in objectives 5,7,8,10,13,15,16, and 17, but were deficient in learning objectives 1,2,6,11, and 14. Based on the results of these surveys, the department made a variety of changes to our curriculum.

1. We added specific spreadsheet exercises to the Fundamental of Watershed Sciences (AWER 3700) and Fish Diversity and Conservation (AWER 3100) courses.
2. We added additional statistical homework assignments in the Fish Diversity Laboratory course (AWER 3110) and the Water Quality and Pollution course (AWER 4530).
3. We moved the learning objective of gaining proficiency in Geographic Information System software and analysis of remote sensing from AWER 4750 to AWER 4930 as this course covers this information well.
4. We have modified the course on Professional Orientation (AWER 1200) to included more examples of the earth's coupled biogeochemical cycles and the impacts that humans have had on the function of our ecosystems.

2. *Exit Interviews with graduating seniors*

In addition to assessment of our learning objectives for specific courses within the curricula, we also conduct exit interviews with each graduating senior. These exit interviews and surveys completed by our graduating students provided varied insights into the successes and failures of our academic programs. Based on these assessment tools, we made the following changes in our curriculum.

1. We replaced the Water Law and Policy course (EnvS 5320) with the Human Dimensions in Natural Resources Management course (EnvS 4000). Ongoing poor course reviews of EnvS 5320, coupled with excellent student reviews of the EnvS 4000 resulted in this change in course requirements.
2. We enhanced the class project aspects of the Water Quality and Pollution class (AWER 4530) and included a series of oral reports presented by small groups of students taking the course. After implementing these changes, this class became one of our senior capstone courses where students are assigned a real world problem and required to develop a resource management plan. The Utah Division of Water Quality assists us in the development of the specific project each year.

3. Capstone Courses

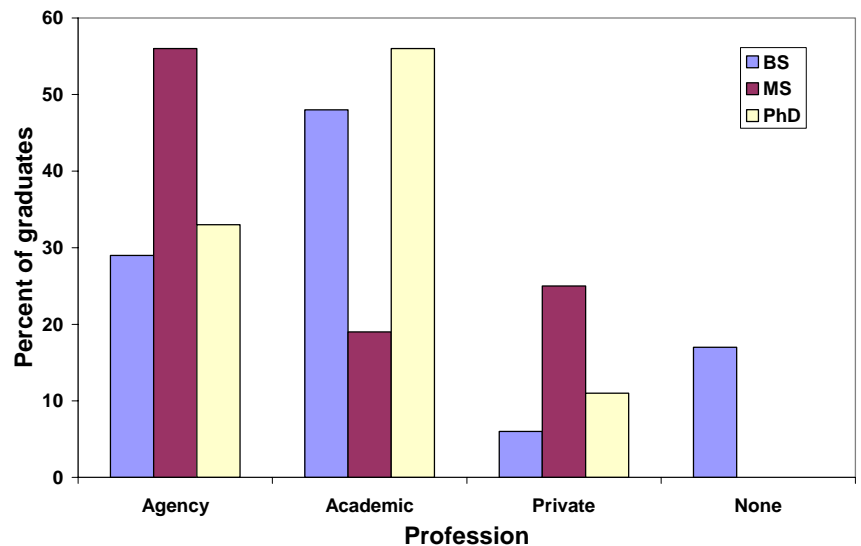
Both degree programs have required capstone experiences that force students to become involved in the analysis of an environmental problem. Students collect, analyze and synthesize data and propose solutions to a given set of problems. Writing skills are emphasized. How the students fare in this capstone experience depends on the degree to which previous courses prepared them for these types of real life issues. Faculty comment on the degree to which individual courses prepares the students for this capstone requirement. These discussions are used to shape the curriculum in future years.

4. Placement of graduates

We have some contact information on 83% of the 58 graduates of our BS programs during the past five years. Almost half of these graduates went on to continue their education in graduate schools (Academic category in Figure 6). Another 30% are employed by natural resources agencies. These include the Utah Division of Wildlife Resources, the US Forest Service, and Idaho Department of Game and Fish. An additional 6% of BS graduates found employment with private consulting firms or non-governmental agencies (Private category in Figure 6).

Students graduating from the Department of Watershed Sciences with a Masters degree found employment with governmental natural resource agencies (Agency), continued their education in PhD programs (Academic), or became employed by private consulting firms or non-governmental agencies (Private) (Figure 6). The nine PhD students that finished their degrees since 2002 are continuing in their careers as post-doctoral research associates in academic institutions (4 students), employed as faculty at an academic institution (1), work for governmental agencies (3), or work for private consulting firms (1).

Fig. 6 Placement of Graduates



Challenges and Recommendations for Academic Programs

Recent changes in our profession have made it clear that a graduate degree is the entry into professions of fisheries and watershed science. During the past five years we have attempted to place more emphasis on our graduate educational programs by emphasizing our PhD program, attempting to recruit from a national pool of applicants for graduate degrees, and increasing research activities to fund the graduate program. We have been somewhat successful in these ventures. Our number of PhD students has increased and a number of MS and PhD graduates have gone on to take leadership position in natural resource agencies. One of our recent MS graduates is now a section head in the Utah Division of Wildlife Resources. Another student who has not quite finished his PhD degree has become a section head of the Utah Division of Water Quality. These former students are now directing programs for the dominant natural resource agencies in our state. Over half of the students earning MS degrees from our department are now employed with state and federal agencies in the west. Our department contributes greatly to the management of our natural resources through our graduates in their positions with the land and species management agencies. Another 20% of our MS graduates have gone on to PhD programs at prestigious universities including Notre Dame, Oregon State University, University of Colorado, and the University of Indiana. Students attaining BS degrees from our department have also become competitive at being accepted into good graduate

programs in Utah and institutions across the county. Over 50% of our finishing undergraduates now go on to graduate programs. This percentage has increased two-fold during the past decade and speaks to the high quality of our undergraduate educational program and the changing job markets in our professions.

In addition to these successes, our department has a number of objectives that need attention. The largest deficiency of our programs has been the relatively low number of graduates who have entered the academy. We have done an excellent job in providing the next generation of agency leaders, but have generally failed in providing similar numbers of future academic leaders. Our efforts to enhance the number of PhD students in our program will help us address this issue. We also need to increase the number of post-doctoral researchers that work in our research laboratories. Gaining employment as a post-doc is almost a requisite for becoming competitive for academic positions. Having the ability for PhD students to interact with the more senior researchers will help give them the perspective to become ready for the extreme competition for these positions. We have increased the number of post-doctoral researchers in our department over the past two years, but we still need to generate more research funding to create additional positions. We have also made a commitment to increase the number of MS students in our department by becoming more involved in the Master of Natural Resources degree. This professional degree program is administered through the College of Natural Resources and allows students to complete the program in two semesters. A number of our colleagues in natural resources agencies have indicated a need to have their employees mentored in such a program. Faculty in the Department of Watershed Sciences have interests in pursuing these opportunities to shape the management of aquatic resources through education of professionals in the field.

C. Faculty

The Department of Watershed Sciences has ten full time equivalent faculty from a diverse set of academic backgrounds (Table 2). Three of our faculty members are women. Two come to us from other countries. All have terminal degrees from outstanding research universities.

Table 2 Watershed Sciences Department Faculty

Matthew Baker	Assistant Professor	PhD	2002	University of Michigan
Phaedra Budy	Associate Professor	PhD	1996	Utah State University
Todd Crowl	Professor	PhD	1989	University of Oklahoma
Charles Hawkins	Professor	PhD	1982	Oregon State University
Tamao Kasahara	Assistant Professor	PhD	2005	York University
Chris Luecke	Full Professor and Head	PhD	1986	University of Washington
Nancy Mesner	Associate Professor and Associate Dean	M.S.E.	1985	University of Washington
John Schmidt	Professor	PhD	1987	The Johns Hopkins University
Helga Van Miegroet	Professor	PhD	1986	University of Washington
Mark Vinson	Research Assistant Professor	PhD	1998	Utah State University
Michael White	Associate Professor	PhD	1999	University of Montana
Wayne Wurtsbaugh	Professor	PhD	1983	University of California, Davis

The faculty of the Watershed Sciences Department have internationally known and nationally recognized research programs. Faculty and their students publish regularly in the best research journals in their fields. During the past 5 years faculty and their students have published over 150 research articles in peer-reviewed journals. This value represents an average of 3 papers per faculty research group per year.

Research

The research productivity of Department of Watershed Sciences faculty results in their Fisheries program begin ranked third in the country in the 2005 Faculty Scholarly Productivity Index. The University of Washington and University of Minnesota were the only Fisheries programs ranked higher in this survey. The inaugural FSP index report, released in January 2007 and based on data from 2005, rates faculty members' scholarly output including the number of books and journal articles published and awards received. Developed by Academic Analytics, a company established in 2005 and partially owned by the State University of New York at Stony Brook, the FSP index ranks 7,294 individual doctoral programs in 104 disciplines at 354 institutions.

Faculty in the Department of Watershed Sciences have been very successful in being awarded competitive research grants from federal and state research agencies (Figure 6). We currently have ongoing research programs totaling over \$5M. These research awards come mainly from competitive funding sources including the National Science Foundation, the US Environmental Protection Agency, US Department of Agriculture, National Aeronautics and Space Administration, and our state fisheries, water quality, and agricultural agencies. Faculty members have been awarded over \$2.5M in new grant funding in each of the past 4 years.

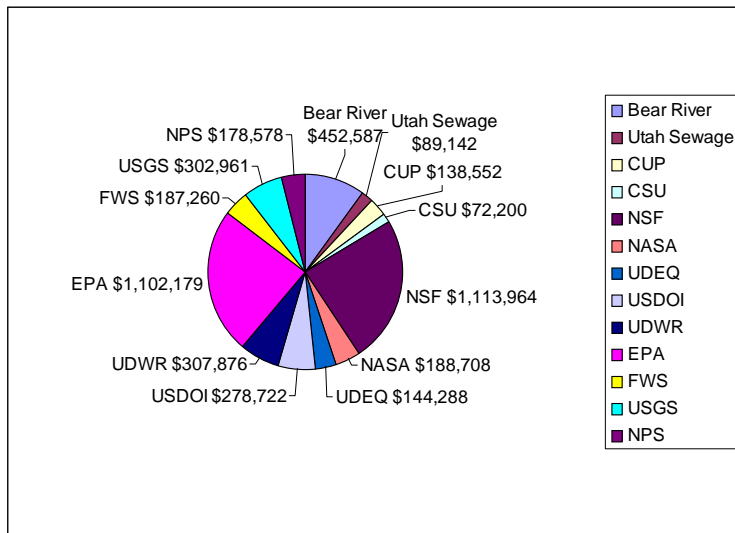


Figure 6. Grants awarded to Watershed Sciences Faculty during the 2005-06 academic year. The total grant dollars exceeded \$3M. This distribution of grant dollars is typical of grants received during the past five years.

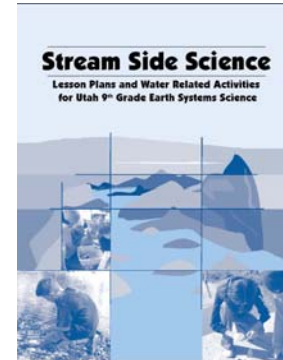
Extension

Our extension program in Water Quality has been very successful in having an impact on our state water quality agencies, in helping communities comply with environmental regulations, and in shaping the K-12 educational systems through teacher training and curriculum development. Extension activities in the Department of Watershed Sciences include:

1. Educational and volunteer programs in which we provide training and materials such as:
 - The Utah Stream Team
 - Project WET

- A River Runs Through Us
 - Utah Lake Watch
 - Adopt -A- Waterbody
 - Stream Side Science 9th Grade Curriculum
2. Youth presentations including hands-on activities and demonstrations brought to your classroom, field day, home school, or event.
 3. Publications and fact sheets on various water quality concerns including best management practices to reduce non-point source pollution, drinking water protection, storm water protection, as well as many classroom activities.
 4. Agricultural and water quality information and education including CNMP, CAFO, AFO, Best Management Practices, and Utah Farmstead Assistance.
 5. How to test your drinking water. Information on how to collect a water sample, where to get your water tested, and how to interpret the results, including an online water quality test toolkit
 6. Booths, displays, and brochures for public events.

The 11 activities in Stream Side Science bring a water focus to a set of standards and objectives in the Utah State Core Curriculum for 9th Grade Earth Systems Science. These hands-on activities help students learn the basic concepts of Earth Systems Science while exploring watershed and water quality issues. Each lesson plan contains background information, step by step instructions for the activity, suggestions for applying the data, and further discussion questions. Student worksheets, sampling instructions, and teacher resource pages are also provided. The curriculum was developed from the more comprehensive set of stream monitoring materials found in the Utah Stream Team Volunteer Monitoring Manual, which is available from Utah State University Water Quality Extension.



Centers and Initiatives

Five research centers are housed in the Department of Watershed Sciences. Three of these are research centers coordinated by federal research agencies, but sited at Utah State University. These include the Utah Cooperative Fisheries and Wildlife Research Unit, administered by the US Geological Survey; the National Aquatic Monitoring Center, administered by the Bureau of Land Management; and the Fish and Aquatic Ecology Unit, administered by the US Forest Service. Two additional research centers are directed by faculty in the Department of Watershed Sciences. Dr. Charles Hawkins is director of the Western Center for Assessment and Monitoring of Freshwater Ecosystems, and Dr. Jack Schmidt is director of the Intermountain Center for River Rehabilitation and Restoration. The Department of Watershed Sciences at Utah State University is a national leader in the development of tools and methods to monitor, assess, and restore our streams and lakes. Our research centers work closely with federal agencies to protect and enhance healthy ecosystems. Below is a sampling of our flagship national programs.

The Utah Cooperative Fisheries and Wildlife Research Unit, coordinates interactions between our state fish and game agency and the Department's research programs. The mission of the Utah Unit 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. Expertise in the unit 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. This research unit works closely with the Utah Division of Wildlife Resources to conduct needed research and educate graduate students in fisheries science. The Department is especially proud of our Watershed Sciences graduate students who recently organized two workshops for the continuing education mission of state agencies. One of these workshops was held in Logan in January 2006 on use of new statistical tools to better interpret natural resources management options. The second workshop was on the use of Geographic Information Systems in aquatic environments and held in conjunction with the Bonneville Chapter of the American Fisheries Society's annual meeting in Park City in March of 2005. A third workshop is being organized by the graduate students and is focused on using bioenergetics models to manage sport fish populations. Dr. Phaedra Budy, Associate Professor in

the Department is Assistant Unit Leader in Fisheries and conducts research in fisheries conservation, population assessment, and trophic dynamics of aquatic systems.

The **National Aquatic Monitoring Center** is a cooperative venture between Utah State University and the U.S. Bureau of Land Management. Our purpose is to encourage and foster scientifically sound watershed monitoring programs on public lands. Our 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 our laboratory is the processing of aquatic invertebrate samples. Please contact us if you are in need of our assistance. Dr. Mark Vinson, assistant research professor in the department, is director of this center.

The mission of the US 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 works with federal and state research organizations and universities to develop and disseminate information to aquatic resource specialists through continuing education workshops, presentations, publications, and on-site visits. Dr. Brett Roper is acting director of this research unit.

The primary mission of the **Western Center for Monitoring and Assessment of Freshwater Ecosystems** 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. Our main goal is to aid federal, state, tribal, and local land and water management agencies in meeting the biological monitoring and assessment objectives required by the United States Clean Water Act and other federal and state environmental legislation. Other goals of the Center are to facilitate communication and collaboration between tribal, state, and federal agencies with respect to their common monitoring and assessment needs; provide technical guidance through workshops and other types of outreach education; and serve as a repository and clearing house for data and information related to aquatic monitoring. Dr. Charles Hawkins is director of the Center.

The **Intermountain Center for River Rehabilitation and Restoration** focuses on education, research, and public outreach leading to the improved practice of river restoration and rehabilitation. This Center coordinates activities in two areas: (1) restoration of small streams and (2) rehabilitation of intermediate and large rivers. Center activities include a vigorous public outreach education program in watershed and stream restoration, initiation of a post-project monitoring program whereby the success of restoration activities is assessed, and support for applied research that leads to the improved practice of stream restoration. The Center will contribute research, workshop, and outreach programs focused on developing improved methods of rehabilitating the nation's intermediate- and large rivers. Dr. Jack Schmidt is director of ICRRR.

During the past three years, ICRRR has been very successful in developing two week long short courses in stream restoration. These courses consist of organized lectures, backed by lecture notes, a reference text on measurement and analysis methods in fluvial geomorphology, spreadsheets, and other relevant reading, field trips, exercises, and discussion. The courses include several field trips to rivers and streams in the area, with its spectacular mountain scenery, diverse fluvial environments, and range of human impacts (and their often very visible consequences). The courses include workshops on geomorphic river restoration problems faced by participants, who briefly present the problem for discussion by instructors and colleagues in workshop format. The first short course is intended for agency and consulting industry professionals and others seeking an overview of the scientific basis of stream restoration. The second short course is for those seeking specific training in sediment transport & geomorphic design of channels. Over 70 professionals in hydrologic and fisheries sciences have completed these short courses during the last three summers.

In addition to housing our research centers, the Department of Watershed Sciences also participates fully in activities of the **Utah State University Water Initiative**. The Water Initiative supports a broad community of students and faculty engaged in water education, research and outreach. This 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. Dr. Jack Schmidt is associate director of the USU Water Initiative.

Research Analysis and Assessment

Research programs in the Department of Watershed Sciences have been successful at changing the science and management of our aquatic resources. Basic research by Dr. Wayne Wurtsbaugh and his colleagues and students on the link between stream inflows and lake environments have led to new syntheses on the integration of physical attributes and biological characteristics of aquatic ecosystems. Results from Dr. Wurtsbaugh's studies on lakes in the Sawtooth Mountains of central Idaho were a central part of a 2001 publication of the American Society of Limnology and Oceanography entitled "The Future of Limnology".

Dr. Jack Schmidt further enhances our department's reputation in linking physical processes to ecological systems in his research on the Colorado River in the Grand Canyon. Jack and his colleagues were instrumental in designing and monitoring results of two planned flood events below Glen Canyon Dam. Results from these two large scale ecosystem experiments indicated to river managers that moving water without associated sediment flows was unlikely to restore the Colorado River system to its former condition.

Dr. Charles Hawkins, Mark Vinson, and Todd Crowl have conducted research that led to changes in the monitoring and assessment of aquatic ecosystems, and the management plans for endangered fishes in Utah. Dr. Hawkins developed methodology for the assessment of biodiversity of stream invertebrates that has recently been adopted by the US-EPA for use in their biological assessments of the health of streams in the United States.

Fisheries research by Dr. Phaedra Budy and Dr. Chris Luecke has led to changes in lake management plans for Bear Lake, Flaming Gorge Reservoir, and Lake Powell. Modification of fish harvest and stocking plans were established to enhance native species, reduce the impacts of exotic species, and increase angler satisfaction with the fisheries resources of the state. Dr. Phaedra Budy was awarded Researcher of the Year in 2004 for her work in this area.

Dr. Mike White, Rob Gillies and Nancy Mesner have developed models and tools to use remotely-sensed satellite images to better manage our urban and agricultural environments. Their research on measurement of impervious surfaces and the relationships between impervious surfaces and water quality allowed Gillies and Mesner to work with communities in Utah to better manage storm water runoff. Dr. White's projection of future climate change is being used by the nation's wine industry to prepare for shifts in the geography of climatic conditions that provide high quality grapes.

These are a few of the highlights of how research by faculty in the Department of Watershed Sciences impacts the use and management of our nation's natural resources. This is an impressive list of accomplishments, but we still strive to make additional inputs into the ecology of our wetlands in Utah and the world, on the effects of toxicants on the health of our streams and lakes and the health of humans consumer aquatic species, and in further efforts to use the new technologies associated with remote sensing to more efficiently assess the health and well being of our aquatic ecosystems.

The faculty in the department have outstanding records of research publication, citation and funding. Over the past four years, the faculty listed in Table 2 have published between 24-35 research articles per year in peer-reviewed journals. Their research is cited by other scientists in over 550 publications per year. The Department of Watershed Sciences provides over \$2.5M per year in contracts and grants, an average of over \$200,000 per faculty member per year.

Challenges and Recommendations of Research and Extension

The research and extension programs in the Department of Watershed Sciences are among the best at Utah State University and compare favorably with similar programs across the country. The publication rate of our faculty is high, rates of external funding for research and extension is extensive, and our outreach programs reach natural resource professionals, community leaders, individual citizens, and K-12 teachers and students. Even with these

successes, we have established goals to accomplish in the next five years. Efforts of Watershed Sciences faculty have strengthened relationships with the Utah Division of Wildlife Resources, the Utah Office of Education, and the Utah Department of Agriculture and Foods. However, our department does not have strong contacts with the Utah Division of Water Quality. We have begun conversations with this agency to attempt to become more involved in their efforts to monitor and protect the state's water resources. We hope to establish an internship program where our graduate students would be funded by the agency and then our graduates would have opportunities to begin full time employment. Both our research and extension programs will work to help our department become more involved in the activities of our water quality agency. Current funding cuts in the Division of Water Quality may make it difficult to initiate this program, but we will continue to implement this type of program. The Department has forged strong relationships with federal agencies such as US-EPA, US Department of Agriculture, the National Science Foundation, the US Forest Service and US BLM. We seek additional opportunities to form closer alliances with the US Geological Survey. We have recently made Dr. David Naftz of the USGS an adjunct professor in Watershed Sciences. Faculty members in our department have been working with Dr. Naftz on research projects concerning water quality and toxicology of organisms living in the Great Salt Lake. The Watershed Sciences Department needs to continue the University efforts to enhance the role of extension into more urban areas. The Water Quality Extension programs efforts to assist communities with management of storm water is one effort in this area that has provided benefits to our program and to the citizens of the state. One of our largest challenges will be to maintain our research funding in this era of shrinking federal budgets. Without continued funding at current levels, the research and graduate education program in the department will become greatly diminished.

Presently two faculty of the Watershed Sciences Department participate in NSF-sponsored Long Term Ecological Research sites, but we have no nationally supported ecological field research program in the intermountain west. In the next few months, our department has the opportunity to become involved with research groups proposing to host a National Ecological Observation Network site (NSF-NEON) in northern Utah, and an intermountain hydrological observatory under the direction of NSF and the Consortium of Universities for the Advancement of Hydrologic Science (CUAHSI). Our challenge is to encourage faculty to become involved in these activities that will likely define much of our nation's environmental research during the coming decades.

D. Support Services

The Department of Watershed Sciences employs two classified staff members. Enid Kelley is the senior administrative assistant, a classified employee due to the vagaries of our Human Resources Department on campus. Enid serves on the board of the classified employees at Utah State University. She provides assistance to the department head and is responsible for human resources, supervision of office staff, and some budgetary issues. Enid is also the webmaster for the Watershed Sciences web site. Enid Kelley fills a 90% position and is able to take extended leaves during December and July of each year. Brian Bailey is also a classified employee. His duties include management of undergraduate and graduate educational programs, interaction with students and the public on a myriad range of issues, and Spanish instructor for our fledgling languages program.

The Department of Watershed Sciences receives \$13,000 per year for operating funds. During the budget cuts of 2004 and 2005 those funds were reduced to \$2,000 per year. Operating expenses for the department average \$60,000 per year. The share of indirect costs returned from grants and contracts by the Vice President for Research provides the funds needed to fill this discrepancy. President Stan Albrecht is working with the Utah Legislature and the Utah State University Vice President for Finance to provide additional operating funds for the departments.

Departmental facilities include a 40 acre experimental fisheries research laboratory at the Millville Predator Ecology Laboratory. This facility includes a fish hatchery building where juvenile fish are spawned and reared for ecological investigations. The facility has state of the art flow through plumbing and disease prevention equipment and allows several faculty members to conduct controlled experiments in a laboratory with thermal and lighting controls. The site also includes six ponds which are used to rearing and experimentation with a variety of fish species. The facility has been approved and certified by University and state fish health inspectors and so can be used for research of endangered fishes.

The Janet Quinney Lawson building contains state of the art facilities for remote sensing and geographic information systems. A Linux computer cluster allows for parallel processing of data from a variety of satellite sensors. This laboratory is well designed for climate and plant phenology investigations related to NASA funded projects on climate change. The Utah Climate Center is also located in this facility. Dr. Robert Gillies is adjunct in the Watershed Sciences Department and director of the Climate Center. Two other Watershed Sciences faculty members have their research labs in this building.

The Department also has office space and research labs for each faculty member, teaching labs for ichthyology, hydrology, limnology, and geomorphology courses. Computer laboratories in the College of Natural Resources are available for use by the Geographic Information System courses. Approximately half of the graduate students have offices in large open rooms to encourage interaction among students. Graduate students that are half way through their programs often are moved to more private offices.

Analysis and Assessment of Support Services

The E&G budget for the Department of Watershed Sciences is comprised almost entirely of salaries with little money for operating expenses, equipment, or support for teaching assistants. Over 97% of our current budget is devoted to salaries and benefits of the ten faculty and two office staff. This budget structure provides little opportunities to shift resources to capture opportunities to enhance our research, teaching, and outreach programs. The \$60,000 - 80,000 that comes to the department from the return on overhead funds does alleviate this problem to some extent. We frequently lose opportunities to begin research in promising areas due to lack of discretionary funds that could be set aside for these purposes. The department does not have a steady source of funds from our development program. New hires in the College of Natural Resources may provide additional means of enhancing this type of funding for future endeavors.

Challenges and Recommendations for Support Services

The severe lack of operating funds is the largest challenge the department faces. We are not able to use the return of overhead funds from research contracts solely to enhance the research program of the Department. These funds are used to pay for phones, mail, teaching assistants, vehicular expenses, and equipment. Increasing the operating funds for the departments will greatly assist in meeting this challenge. The lack of space for visiting scientists and for post-doctoral research associates is also a problem. We attempt to work as a college to alleviate the greatest needs in this area. Usually this approach is helpful in solving immediate problems. New space will be needed if the research programs in our department are to grow.

The recent hiring of Jon Paulding as development director for our college provides new opportunities for our department to begin long term research on environmental assessment and restoration. The departmental research centers directed by Dr. Charles Hawkins and Jack Schmidt should be able to use their focus on environmental sustainability to encourage donors to support research in these areas. Our plan is to host open houses for these research centers to prospective donors within the next year.