

**Relevancy – Introduction**

We propose to establish the Northern Colorado WAMS that will focus on: WAMS Grant Program Goal 1) - the recruitment and retention of women and minority HS students from rural schools in northern Colorado into the study of ecosystem science, natural resources, and climate change on regional ecosystems and possible solutions to the consequences of these changes to society, and WAMS Grant Program Goal 2) - teacher professional development that provides research and internship opportunities in said areas of study to increase their content knowledge in these areas and to foster greater interaction and familiarity with postsecondary faculty and degree programs to increase student interest and to facilitate recruitment of students in these area. The program builds on a collaborative inter-disciplinary research history of national and international repute at the Natural Resource Ecology Laboratory (NREL), the newly established Department of Ecosystem Science and Sustainability (ESS) within the Warner College of Natural Resources at Colorado State University (CSU), The Poudre Learning Center (PLC), and the Centennial

Board of Cooperative Educational Services (BOCES).

The project directly addresses both of the WAMS Grant Program Goals from Part I, B of the RFP (USDA-NIFA-WAMS-004209). For WAMS

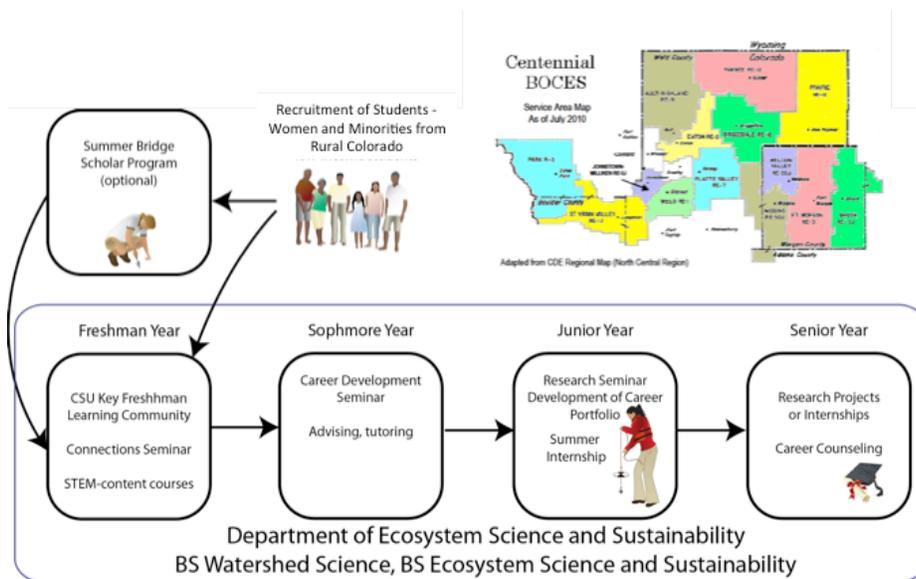


Figure 1. Rural school districts within Recruitment area served by the Centennial BOCES and flowchart of planned activities of the Northern Colorado WAMS project.

Grant Program Goal 1 that focuses on the development of a recruitment and retention plan for women and minorities from rural areas in northeastern Colorado (Figure 1), ESS WAMS student fellows will participate in three CSU programs - the *Summer Bridge Program* for recent HS graduates and *CSU Key Freshman Learning Communities* that include students taking common courses and living in the same dormitory, coupled with courses and seminars that foster professional development and bridge the science to societal issues, and the *BS degree programs in the Department of Ecosystem Science and Sustainability* that stress content knowledge through coursework, research and internships, and opportunities to communicate their findings at professional conferences. For WAMS Grant Program Goal 2 aimed at fostering partnerships among academic institutions and employers who develop sustainable research, WAMS teacher fellows will participate in *summer and academic year research internships* and in *the teacher-in-residence program* coordinated at Colorado State University.

**A Rich History of Collaboration and Experience:** Our partnership has extensive experience working with USDA-funded programs (National Needs Fellowship Program), USDE-funded programs (Upward Bound, Mathematics and Science Upward Bound), and NSF-funded programs (GK-12, Mathematics and Science Partnership, Research Assistance for Minority High School Experiences) at the K-12, undergraduate and graduate levels aimed at increasing the participation of women and underrepresented minorities, including those from rural areas in STEM discipline (see Current and Pending Support documents and CVs). Our goals, objectives and proposed activities include program elements from these experiences and are aligned with WAMS Program Goals. Our plan emerged from the Logic Model presented in narrative form below, summarized in Section 2, and presented in the Logic Model Appendix. We will heighten the awareness and preparation of women and underrepresented minorities from rural Colorado

high schools for relevant STEM majors at CSU through direct engagement in the schools as part of our recruitment activities and through the professional development of their teachers through our teacher-in-residence and research experiences for teachers programs. We will facilitate the transition from high school to the university through orientations and a summer bridge program. We will provide students with an instructional path and advising services aimed at increasing retention and their success in their degree programs and careers.

**Project Goals:** We propose a suite of program, student/teacher fellow-centered, and institutional goals, aimed at increasing the participation of women and underrepresented minorities from rural areas in STEM fields that are relevant to the USDA mission. **Program Goals - 1:** Recruit and retain 3 cohorts of 5 women and minorities from rural high schools in northern Colorado (Centennial BOCES) into the BS in Ecosystem Science and Sustainability or BS in Watershed Science; **2:** Provide the students with a multi-year educational experience that includes courses, seminars, research and internship opportunities, and career advising; **3:** Recruit 3 cohorts of up to 5 teachers per year from rural High Schools within the Centennial BOCES to participate in professional development workshops, research internships, and/or as teachers-in-residence.

**Student/Teacher Fellows-Centered Goals - 4:** Create a scholarly environment to promote research skills and intellectual development; **5:** Provide an environment in which student and teacher fellows explore environmental questions and discuss solutions to society's environmental challenges; **6:** Provide a professional development environment that addresses the personal and social needs of the student fellows that enables them to pursue a career in ecology. **Institutional Goal - 7:** Provide a professional environment that addresses the personal and social needs of the fellows that enables them to pursue a career in an ecosystem or watershed science-related field.

**Program Activities:** Our program adopts characteristics identified by an NSF-sponsored

working group on undergraduate research centers (Pemberton and Lee 2003), USDE sponsored programs for K-12 outreach for at-risk students (Berkowitz 1997, Myers and Schirm 1999), and our own experiences mentioned above. With this, WAMS student fellows will participate in three CSU programs - the *Summer Bridge Scholar Program* and *CSU Key Freshman Learning Communities* that include students taking common courses and living in the same dormitory, coupled with courses and seminars that foster professional development and bridge the science to societal issues, the *BS degree programs in the Department of Ecosystem Science and Sustainability* that stress STEM content knowledge through coursework, research and internships, and opportunities to communicate their findings at professional conferences. WAMS teacher fellows will have the opportunity to serve as a teacher-in-residence or be provided a research fellowship to participate as a member a research team. Below we present details of each of the proposed student activities accompanied our plans to enhance and augment these program through WAMS activities and our plan to sustain and institutionalize the activities.

***CSU Summer Bridge Scholars Program*** - The program provides early admission to Colorado State University to freshmen applicants who from underrepresented backgrounds during the summer between high school graduation and the freshman year. The program is designed to assist students from underrepresented backgrounds to make a successful transition to Colorado State University and increase retention through an intensive on-campus "Bridge" experience. It provides students with an award to cover room & board, tuition & fees, and books and supplies. It helps students to enhance academic skills through group study and supplemental instruction, creates campus resource connections, and to participate in leadership development activities. Our WAMS project will support up to 4 bridge scholars during the 8-week grant period that choose one of the majors in the Department of Ecosystem Science and Sustainability, and award them an

NOCO WAMS fellowship upon successful completion of the summer session.

***CSU Key Freshman Learning Communities (1st year experience)*** - Four cohorts of up to 5 Freshman WAMS fellows (Summer Bridge Fellows and regular Fall admission Fellows) will be placed in one of the *CSU Key Freshman Learning Communities* that consist of 18 students from similar backgrounds. The learning communities are designed to increase retention, academic performance, and student satisfaction with their university experience and choice of major. Grounded in the values of academic excellence, leadership development, service-learning, and gaining and awareness and appreciation of diversity, the learning communities will focus on active and experiential learning through interdisciplinary learning, service-learning, and undergraduate research. Freshman students will work with upper-class mentors on a successful academic and social transition to college, obtain mid-semester grades on their academic performance, attend workshops on academic skill building, and integrate service-learning opportunities. Freshman learning community students will co-enroll in the requisite STEM course (i.e., CHEM 111/112, General Chemistry and Lab, and LIFE 102, Attributes of Living Systems and Lab), the first required ESS course (ESS 130 – *Systems Theory and Information Management*) and general education courses.

***Department of Ecosystem Science and Sustainability (ESS) Degree Programs*** - Students will enroll in either the BS in Watershed Science or the BS in Ecosystem Science and Sustainability offered through ESS. The BS in Watershed Science was established over 50 years ago and represents one of the more prestigious degree programs of its type in the country. The new BS in Ecosystem Science and Sustainability represents one of the first of its kind in the country. The first two years of each program are aligned to require a solid grounding in physical and natural sciences and mathematics in preparation for upper division courses. Both degrees require a

freshman level course entitled *Systems Theory and Information Management* (ESS 130) and a sophomore-level course entitled the *Fundamentals of Ecosystem Science* (ESS 211). The Watershed Science degree includes a core of classes on watershed measurements, water quality, snow hydrology and watershed analysis. The Ecosystem Science and Sustainability degree emphasizes fundamental ecosystem science, earth system science, and the study of social-ecological systems. Both degrees emphasize experiential learning. The programs capitalize on CSU's proximity to the Rocky Mountains, High Plains, and inter-montane basins of Colorado, to give students unique educational opportunities in outdoor laboratories, as well as in traditional classrooms and laboratory settings. Upper-level undergraduates are required to participate in a practicum and capstone experience that might include research and internships, volunteer activities, or co-operative educational opportunities or summer jobs to enhance practical training and development.

***Enhancements of Existing Structures*** - The *Summer Bridge Scholar* and the *Key Freshman Learning Community Programs* will be enhanced by direct involvement of NREL scientists and ESS faculty in the development and delivery of courses. The degree programs will be enhanced through the formalization of the required practicum and capstone experiences within each degree program and, as with the lower division coursework, the formalization of the alignment of these requirements across degree program that draws from common skill sets the degrees share, yet preserves the unique features that each possesses.

***New Support Structures*** - New support structures include a fall freshmen orientation and the development of a series of seminars that stress career options and professional development skills. Students will participate in a *Career Development Seminar* and a *Foundations of Research Seminar* (see below) that focus on research in the sciences and multiple research rotations

exposing them to different projects and approaches. A graduate student will serve as the Research Community coordinator and the Teaching Assistant for the *Foundations of Research Seminar*. We will initially offer these seminars as elective credits. With refinements and lessons learned from the S-STEM program, the seminars will later become a formal part of our curricula.

***Connection Seminars*** - Freshman S-STEM Scholars will enroll in a 1-credit *Connection Seminar*. Studies from high school and undergraduate research programs emphasize the need for students to conduct their own original research that is both scientifically and socially relevant (Kardash 2000, Bauer and Bennett 2003, Rahm et al. 2003, Lopatto 2004, Seymour et al. 2004, Rahm et al. 2005, Russell 2005). The broader context of science is an important component in the retention of all students, but resonates strongly for students from under-represented groups (Beane 1988, McBay 1989, Tobias 1990, Lipson and Tobias 1991, Siebert 1992, BSCS 1993, NSF 2004). Seminars will cover topics that connect environmental research to societal issues, such as *Population Growth and Cultural Change, Land-use Dynamics, Genetic Engineering and Biological Diversity, Resource Use and Global Change, Water Quality, and Water Resource Management*. The seminars will include guest lectures from faculty and professional, weekly readings and recitation, and presentations of research projects and internships experiences by WAMS Fellows. These seminars will introduce students to the types of research topics they might pursue later in their degree program with an emphasis on topics they will find most engaging and relevant for their future career paths.

***Career Development and Foundations of Research Seminar*** - Sophomore and junior S-STEM scholars will enroll in a 1-credit Career Development seminar and a 1- credit Foundations of Research Seminar. The seminars will cover career paths in ecosystem and watershed science, the nature and expectations of research, data collection and integrity, ethics in science, as well as

essential job skills such as resume preparation, interview practice, networking skills, and professional communication. Seminar content will include presentations of research and internship experiences and opportunities for students by the mentors. The seminar will be developed by faculty and offered in collaboration with the career liaison in Dean's office to promote job placement. These seminars are intended to facilitate students' transition from initial ideas about career options to active engagement in securing future STEM careers. They will be structured to promote student confidence and help them build strategies for success that will keep them both enrolled in the degree programs and involved in STEM disciplines after graduation.

***Junior-Senior Research and Internship Experience*** - Research and internship experiences coupled with coursework will be the focal points for juniors and seniors. Active engagement of undergraduates in research is essential to their education and career development (Kolb 1984, NSF 1997, McNeal and D'Avanzo 1997, Siebert and McIntosh 2001, Bowman and Stage 2002, Handelsman et al. 2004, Lopatto 2005). Our plan exposes students to research in the following three phases: ***1) Research/Internship Rotations*** - We will adapt a model for internships that is currently offered as a course option to our seniors. Undergraduates are paired with mentors (graduate students, postdoctoral associates, faculty) who either involve the students in their research projects or pair students with internships in local government agencies, consulting firms, or non-profit organizations. Students work alongside up to 3 mentors for a total of 45 hours participating in research or internship opportunity for the 15-week term. The mentor shares with the student basis of research or job, reinforcing lessons from the career development seminar. Following the rotations, students write a paper in either scientific or journalistic format pertaining to their experience. This can be either a formal term paper or a paper in the form of a

popular press article. The paper elucidates the student's knowledge of the projects and of what they learned about science and themselves from the experience. All students make a final presentation to share their work with other members of the class and the mentors. The final presentation is in the form of a PowerPoint presentation, a poster, or a video documentary. The student receives 400-level credit for each rotation. **2) *Research/Internship Proposal***

***Development*** - Following the rotations discussed above, student will develop a research proposal, conduct their research and prepare a final report and present their findings at a professional forum. Once the student has settled on a topic and mentor, the student moves to the proposal development phase where they work with their mentor to formalize their research questions, develop testable hypotheses, and design the plan of study. Students will give presentations of their proposals to other students and faculty at one of the weekly connection seminars for feedback. This practice will reinforce the development of presentation skills, writing skills and promote the practice of peer-review and professional critique in a mentored and friendly environment. The student receives one 400-level credit. **3) *Individualized Research***

***Projects and Internship Opportunities*** - The research topics will focus on the current state and vulnerability of Front Range ecosystems, with studies aimed at climate, natural disturbance, human use, and biotic interactions. The research is interdisciplinary stressing the interactions among components, but is coordinated into the core environmental studies and natural resource-related areas of **Biodiversity and Ecosystem Function, Climate Change and Biogeochemistry, Grassland Ecosystem Ecology, Socio-Environmental Interactions, Soil Sustainability, and Watershed Science and Sustainability**. Scientists specialize in one area of expertise, contribute to others, and engage in discussion through regular meetings and seminars. Students will share in this practice by developing a project within one area but having rotated

among areas through their internship rotations to assist in data collection, to learn new skills, and participate in scheduled discussions and seminars. Students receive 2 credit(s) of NR 495 or equivalent with recitation designed to help finalize their project.

***Presentation and Dissemination of Research*** - Students will be required to present their proposals, preliminary results and findings to their peers at the seminars and laboratory meetings, and the scientific community at regional and national professional meetings. They will also be encouraged to publish their findings in a professional journal. Presentations and attendance at professional meetings is critical to professional development and career advancement. We will adopt the model of supporting students to attend professional meetings at all stages of their development to experience how scientists interact and communicate, and to present findings at meetings that are appropriate for their stage of development. At the early phases of development we will support student attendance and presentations at introductory forums with students at later phases being supported to attend advanced forums. For introductory forums we are fortunate to have three well-established annual symposia within the region where students can present their findings – The Colorado-Wyoming Junior Academy of Sciences and the Front Range Student Ecology Symposium, which is sponsored by the CSU Graduate Degree Program in Ecology, and the American Geophysical Union-sponsored Hydrology Days conference. These forums invite undergraduate and graduate students from Colleges and Universities throughout the region to present their research to other students and faculty. At the national level, we will encourage presentations at the Annual meeting of the National Council of Undergraduate Research (NCUR) and the Society for the Advancement of Chicano and Native American in Science (SACNAS). These forums provide professional venues geared towards supporting undergraduates and in the case of SACNAS students from similar cultural backgrounds, providing opportunities for

networking and constructive feedback. For advanced forums we will support students in the later stages of the program to attend national and international meetings (e.g., American Geophysical Union, Ecological Society of America, Soil Ecology Society, American Society of Microbiologists, etc.). The importance of publications to career advancement in the sciences cannot be understated. Throughout the tenure of a fellow WAMS we will promote publication through the proposed workshops and seminars by providing regular readings and recitation of papers, instruction on writing, and tips on selecting journals, submitting papers and peer-review. These experiences are aimed at preparing students to publish their findings in peer-reviewed professional journals.

**CSU Teachers-in-Residence (TiR) Program:** The program funds sabbaticals for K-12 teachers as part of their career development, including enrollment in graduate programs, research internships, and curriculum and program development. Funding is provided either entirely through the university, or is jointly funded by the university and participating school districts. The TiR will be housed at the Poudre Learning Center and will assist in the development and implementation of the student recruitment plan, the engagement of higher education faculty and staff with the schools in the partnership, and in ensuring that teachers within the partnership are familiar with the program goals, academic options at CSU, and the steps needed to prepare their students for these options.

**CSU Research Experiences for Teachers (RET) Program:** The program provides K-12 teachers with research experiences at CSU during the summer and academic year (time permitting) as part of their professional development. The program stresses more than the increase in content knowledge gained and understanding of science practice, focusing on how best to align the experiences with state science and mathematics content standards, and transfer

them to the classroom. The RET program serves additional functions that are germane to the WAMS project. The program promotes direct engagement of K-12 teachers with university faculty, post-doctoral fellows, research associates, and graduate students. Our project will capitalize on these interactions to familiarize the higher education community with the needs of K-12 teachers and their students, and to familiarize the K-12 teachers with the program requirements and options that are available to their students at the university.

### **Expected Outcomes and Evaluation**

Our evaluation plan emerged from the Logic Model developed by the project leadership in consultation with the external evaluator (*see* Appendix – Logic Model). The evaluation of the project will be coordinated by an external evaluator (Dr. Rose Shaw, Metrics, Inc. – letter attached) in consultation with the project leadership. The objectives of the formative and summative project evaluation processes are to use qualitative and quantitative data to 1) provide a process for refining and improving project implementation, 2) measure the success of the project in meeting its goals and objectives, and 3) assess the impact of the project on participating WAMS fellows.

**Pre-project to post-project assessments:** Our project aims to increase the enrollments and retention of women and underrepresented minorities from rural areas into degree programs (B.S. in Ecosystem Science and Sustainability, and the B.S. in Watershed Science) within the Department of Ecosystem Science and Sustainability at Colorado State University (Goal 1), to prepare them for environmental science and natural resource-related careers (Goals 2-6). Goal 1 will be assessed by comparing the pre-project enrollments to post-project in the number of women and underrepresented minorities from our target rural areas and beyond. The following assessments and outcomes (pre-project to post-project) will be used to determine whether or not

students participating in the project have acquired the necessary knowledge, research skills and interest in a career in environmental science and natural resource-related areas (Goals 2-6): 1) (Goals 2, and 4) assessment of student knowledge of major concepts and issues in ecosystem science, natural resources, and climate change on regional ecosystems; 2) (Goals 2 and 4) student self-assessment of the fourteen research skills (Kardash 2000); 3) (Goals 2, 3 and 4) faculty mentor assessment of each student's fourteen research skills; 4) (Goals 2, 3 and 4) ability to apply higher-order research and professional skills (e.g., developing research questions and hypotheses, assessing policy options and decisions, using data to reformulate a hypothesis); 5) (Goals 2, 3, and 4) ability to effectively communicate and defend a position with scientific information and evidence; 6) (Goals 2, 3, and 4) skills at documenting field and laboratory work; 7) (Goal 5) success at working collaboratively; 8) (Goal 5) interest and commitment to a career in environmental science and natural resource-related areas; 9) (Goal 4) understanding of the STEM disciplines of ecosystem and watershed science and how they benefit and contribute to society; and 10) (Goal 5) development of a realistic graduate school and career plan with milestones. Retention, GPAs, and graduation of the S-STEM students will be compared to non-S-STEM CSU students pursuing related degrees (Goals 1 and 6).

Tracking procedures established by the evaluator for related programs will be modified and aligned with this project. We will contact project alumni for the project's influence on skills, interests, graduate education and career plans. To assess the project's impact will collect the following data: 1) (Goal 1) SES status and gender of each student; 2) (Goals 3 and 6) pre/post assessments of students' perspectives of CSU climate, interests and career plans using the Student Survey; 3) (Goal 2) pre/post course skills and knowledge assessed by course instructors; 4) (Goals 2 and 3) general intellectual gains of students using the absolute, transitional,

independent and contextual knowing stages of intellectual development (Magolda 1992); 5) (Goals 2, 3, 4 and 5) documentation of participation in professional meetings, presentations and poster sessions; 6) (Goal 5) documentation of awards and scholarships; and 7) (Goals 5 and 6) feedback on project impact from alumni including the number and diversity of individuals completing STEM degrees.

**Plans for a reproducible, scalable, and portable pathway:** Goal 7 addresses the extent to which the proposed pathway is reproducible, scalable, and portable through our ability to institutionalize the program activities. It is important to note that our project knits together successful programs at the university and within our partnership but targeted at women and underrepresented minorities in rural areas. We have introduced here some novel components to better connect higher education with K-12 and to connect student affair with academic affairs at CSU to achieve these ends.

**Plans to identify successes and build upon and disseminate them:** The project leadership in collaboration with the external evaluator will monitor and document how well the project is moving toward its anticipated goals. Feedback from mentoring faculty will be collected by the administrative team regularly, and each semester by the evaluator. Dr. Shaw will collect information annually using a survey with comparative analysis over the life of the project. We will maintain records on recruitment and selection, the effectiveness of courses, faculty mentoring methods, student mentoring success, student research and career planning in coordination with the student affairs offices.

### **Technical Merit**

**Beneficiary target audience(s):** Our project focuses on the needs of students (80% of Budget) and teachers (20% of Budget) from rural, underrepresented communities across North Central

and Northeast Colorado represented by the Centennial Board of Cooperative Educational Services and served by the Poudre Learning Center. The Centennial BOCES provides a variety of services to member school districts with approximately 39,000 students across a geographical area of 5,853 square miles in Weld, Boulder, Morgan, Adams and Larimer counties of Colorado. This project represents the first of its kind in within the region designed specifically to provide high quality, meaningful learning experiences for women and underrepresented in STEM careers who live in our rural communities.

Based on data provided by the Colorado Department of Education, 12 of the school districts within the Centennial BOCES serving 14,868 students are defined as “Small and Rural” or “Rural”(Table 1), with 9,165 minority students. Additionally, the percentage of students living live in poverty (as measured by eligibility for Free and Reduced Meals) in our targeted districts ranges from 30 to almost 70%. Many of our districts also have high oncentrations of ELL students from diverse ethnic backgrounds. While the majority of our ELL students identify as Hispanic/Latino, we have a large, growing population of students who are also identified as refugees. Our students with refugee backgrounds have roots in East Africa and Burma and are

enrolled mainly in the Fort Morgan School District. Due to the extremely limited educational opportunities in their countries of origin and the refugee camps, the vast majority

Table 1: Rural school districts within the Centennial BOCES			
School	Student Count	% Female	% Minority
<b>Fort Morgan RE 3</b>	3153	47.95	66.00
<b>Brush RE 2J</b>	1547	50.74	52.49
<b>Weldon Valley RE 20J</b>	210	51.90	11.9
<b>Wiggins RE 50J</b>	550	49.64	30.91
Pawnee RE 12	88	42.05	0.045
Briggsdale RE 10	162	51.85	48.15
Prairie RE 11	181	50.28	40.72
Ault Highland RE 9	770	50.52	37.03
Platte Valley RE 7	1047	48.52	30.66
Eaton RE 2	1804	48.78	24.28
Weld RE 1	1993	47.59	52.41
Johnstown-Milliken RE 5J	3363	47.58	33.42

of these students enter school with limited, or no skills in literacy, math or science. The four districts identified in bold in our targeted list in Table 1 will have highest priority in this program due to the fact Morgan County was identified by CDE as one of the most underrepresented STEM counties in Colorado.

**Adequacy of activities to meet the needs of the targeted audience:** Concepts and strategies that will be essential for us to meet our goals include adopting diverse and adaptive strategies to meet the needs of students, implementing place-based education, and focusing on science that is relevant.

***Diverse and Adaptive Strategies*** - Preparing scientists to address our challenges places new demands on academic communities. Our research knowledge base remains incomplete and our curricula and degree programs may not mesh with the emerging science. Compounding this challenge is the severe mismatch between the national and STEM professional ethnic and socio-cultural demographics (NSF 2004). For example, though 33% of the U.S. population falls into the census categories of African American, Asian American, Hawaiian/Pacific Islander, Hispanic, or Native American, fewer than 4% of ecologists in the U.S. and historically fewer than 15% of the students in ecology-related disciplines within our partner universities are from groups under-represented in STEM (ESA 2006, CSU Institutional Statistics 2006, U.S. Census, 2004). To fully address these environmental issues all of society must participated in the dialog. We must be proactive in our efforts to increase the diversity of the academy in ways that resonate with all segments of the population. The traditional strategies used to engage middle class and upper class white students are not adequate when trying to affect a diverse student body (Thomason and Thurber 1999). We will use strategies that share elements with traditional ones but that also respond to the needs and traditional barriers of students from under-represented and

low income groups (Astone and Nunez-Wormack 1991, Stewart et al. 1997). For example, published studies and our own experiences show that an effective way to engage Hispanic and Native American students involves direct contacts within the community and with parents (Lowenstein 1997, Talbert et al. 1999, Walker and Schultz 2000-2001). Amaral et al. (2002) found that the longer English language learner (ELL) students were exposed to an inquiry-based science program, the higher their achievement scores in science, and writing.

***Place-based Education*** - In recent years the focus on locally-relevant environmental education has resulted in a focus on “place-based education” programs. Woodhouse and Knapp (2000) noted that place-based education is experiential, including content that is specific to the dynamics of an area, multidisciplinary (e.g., science and language), and supports explicit connections between oneself and the community. In short, place-based education is a conduit for relevant and responsive teaching and learning (PEEC 2003). Westervelt (2007) makes a compelling case for implementing place-based programs for improving academic achievement (cognitive outcomes), attitudes and disposition (affective outcomes), and student behavior (psychomotor outcomes). Several studies have demonstrated that place-based approaches lead to significant gains in standardized test scores, GPA, and problem-solving skills (Lieberman and Hoody 1998, Glenn 2000), and have significant positive impact in several arenas including *motivating educators, transforming school culture, and helping students learn* (Duffin and PEER Associates 2007). Our program will focus on coupled human-ecosystem interactions at multiple spatial scales through instruction and through research and internship experiences

***Science that is Relevant*** - Anthropogenic influences on the environment are well documented (Matson et al. 1997, Palmer et al. 2004). In response, the National Research Council and NASA recently identified biogeochemical cycles, biological diversity, climate variability, hydrological

forecasting, infectious disease, land use dynamics, institutions and resources, and invasive species as the grand challenges facing environmental science. Advancing science in these areas is crucial for solving the pressing environmental problems facing society today and will require a social-ecological perspective (Collins et al. 2007, 2011). The Front Range of Colorado as a region provides an ideal place-based microcosm for studying local and regional social-ecological questions. The region has been the focus of ecological research since the Dust Bowls of the 1930's, the International Biological Program of the late 1960's, as a NSF LTER site since 1984, and a NEON site since 2011. In the past 150 years the region has seen the extirpation of Native Americans and bison, the introduction of cattle ranches, misguided farming practice at the beginning of the 20th century, conservation and management efforts following the Great Depression and WWII, explosive growth along the Front Range of the Rockies, large water diversion projects, to the recent ex-urban encroachment. In short, the ecosystems and watersheds of the region have witnessed a confluence of anthropogenic impacts that encapsulates each of the NRC grand challenges. We have an opportunity to introduce undergraduates to the interdisciplinary nature of studying ecosystem and watershed science from a social-ecological perspective (Collins et al. 2011) through research and to discuss the social implications of human activities in the region through connection seminars.

**Project Impact:** The project has the potential to have a significant impact on the number of women and underrepresented minorities from rural areas trained and placed in the STEM workforce (see Table 2), the value of their enterprise, and the needs of the targeted audience. In Colorado, Weld, CO is ranked fourth in terms of the percentage of the population in poverty at 14.9% with a per capita income of Weld County was \$22,920, which is lower than the Colorado average of \$28,723 and the national average of \$26,059 (per the 2010 census). Yet, the county is

Table 2. Workforce demographics in Weld County, CO. (www.usa.com/weld-county-co-income-and-careers.htm)	Weld County	%	Colorado	U.S.
Civilian Employed, 16 Years and Over	118.7K	-	2.45M	139M
Male	63,528	53.53%	53.05%	52.06%
Management, Professional, and Related	17,411	27.41%	37.52%	32.77%
Service	9,202	14.48%	13.77%	14.98%
Sales and Office	10,811	17.02%	18.51%	17.82%
Farming, Fishing, and Forestry	1,216	1.91%	0.78%	1.17%
Construction, Extraction, Maintenance, and Repair	9,387	14.78%	10.78%	9.50%
Production, Transportation, and Material Moving	12,116	19.07%	13.33%	17.70%
Female	55,150	46.47%	46.95%	47.94%
Management, Professional, and Related	20,556	37.27%	42.07%	39.40%
Service	10,692	19.39%	20.84%	21.33%
Sales and Office	19,274	34.95%	31.93%	32.73%
Farming, Fishing, and Forestry	366	0.66%	0.20%	0.30%
Construction, Extraction, Maintenance, and Repair	220	0.40%	0.45%	0.29%
Production, Transportation, and Material Moving	3,924	7.12%	4.23%	5.67%

ranked second with the Agriculture, Forestry, Fishing, Hunting, Mining Workers Percentage of 3.8%. Reports by Colorado State University and local firms place starting salaries for recent graduates in jobs in Environmental Science and Natural Resources-related fields between \$32,500-\$41,600.

### Achievability

**Probability of project success:** Colorado graduates over 12,500 minority high school students annually, with over 1000 from school districts within our target regional. CSU has a strong record of attracting underrepresented minority students in STEM disciplines. In the past year, underrepresented minority enrollments in STEM disciplines at CSU was ~548 students (10% of total STEM enrollments), the majority of which enroll in environmental-related disciplines.

**Plans to Sustain Program Activities:** We propose to sustain the new fellowships through a combination of foundation sources, departmental IDC recovery, and direct support from research grants as part of the Broader Impact activities. At the end of the granting period we will have 15 students that had been awarded WAMS fellowships. We will work to place these students and in-

coming eligible students into existing programs, through funds available from NREL and ESS departmental grants for undergraduate research and field support, by placing students onto other grant efforts that include support for students, through NSF REU supplements, and through ongoing development efforts. This will require a re-thinking of the allocation of existing resources and generating new sources. The courses and seminars require FTE that will be covered from existing FTE pools to support the degree programs. The administrative FTE needed to coordinate the research experiences will be sustained through the Department of Ecosystem Science and Sustainability and the NREL. The activities described in the preparatory phase will be coordinated through Department of Ecosystem Science and Sustainability. Funding from this grant will establish the logistical plan and campus connection. We will begin this process immediately with the aim of replacing USDA funds after year 3.

### **Key personnel**

**Dr. John C. Moore:** Professor and head of the department of Ecosystem Science and Sustainability and director and senior research scientist of the Natural Resource Ecology Laboratory. His research focuses on food web ecology and the responses of ecosystems to human and anthropogenic disturbances. He has 28 years of program experience and development aimed at increasing access and opportunities for women and underrepresented minorities, and with teacher professional development through USDE TRIO programs, NSF grants (GK-12, MSP, CLT, RAMHSS), and USDA grants (National Needs Fellowships program and Soil Ecology Education). **Dr. Randal Boone:** Faculty member of the department of Ecosystem Science and Sustainability and senior research scientist of the Natural Resource Ecology Laboratory. He has been conducting research in movement ecology of wildlife and livestock, landscape ecology, and systems modeling for more than 20 years, as reported in more than 60

journal articles and book chapters. He teaches spatial analysis methods (GIS), ecology, and modeling techniques, and has mentored many graduate and undergraduate students. He has collaborated with high and middle school teachers to develop modules used in teaching climate change. Dr. Boone will participate in this project as part of his role as undergraduate coordinator for the Ecosystem Science and Sustainability degree program at Colorado State University. **Dr.**

**Gillian Bowser:** Affiliate faculty member of the department of Ecosystem Science and Sustainability and research scientist of the Natural Resource Ecology Laboratory. Her research focuses on biodiversity and connecting underrepresented students and communities to the STEM disciplines. She also is the lead for the Global Women Scholars Network which connects underrepresented women scientists in the field of sustainability using networks and mentoring systems. She has collaborated with community organizations to develop biodiversity surveys that combine science with education and works closely with minority organizations and students. Dr. Bowser will participate in this project as part of her work in both NREL and Ethnic studies in increasing the representation and persistence of underrepresented minorities in science. **Dr.**

**Rich Conant:** Faculty member of the department of Ecosystem Science and Sustainability and senior research scientist of the Natural Resource Ecology Laboratory. His research focuses on understanding the feedbacks between human activities and ecosystem biogeochemistry. He is involved in curricular development efforts focused on human impacts on the global carbon cycle and has mentored undergraduate minority and female students from rural areas in a variety of research subjects. **Dr. Oscar Felix:** Director of the CSU Access Center. He brings 24 years of experience in educational access and outreach programs in rural areas of northern and northeastern Colorado. This experience includes direct services, program administration, grant writing, and project compliance. Experienced in program development for women and

underrepresented minorities from low-income, first generation backgrounds. Curriculum includes mentoring, career-shadowing, study-skills, instruction in sciences and math, and college enrollment information. **Dr. Stephanie Kampf:** Assistant Professor in Watershed Science in the department of Ecosystem Science and Sustainability and research scientist of the Natural Resource Ecology Laboratory. Six years of experience teaching and advising undergraduate students from freshman to senior level. Her present and past advisees and students in the Watershed Science program include women, underrepresented minorities, and students from rural areas, and through her role as advisor of the Watershed Club student group, she has worked to promote broad student participation and engagement in water-related research, education, and outreach projects. She has been involved in K-12 outreach programs for girls through the Environmental Learning Center at CSU and participated in multiple projects that partner K-12 and higher education. **Mr. Mark Rangel:** Public educator for 24 years, he also serves as private educational consultant and professional developer. Instructional Program Coordinator for Centennial BOCES, prepare consolidate grant application for 12 rural member school districts and provide regional support to 52 school districts migrant programs in northern Colorado. Provides regional support to the Migrant Education Newcomer Academy in Fort Morgan School District. **Mr. Ray Tschillard:** Director of the Poudre Learning Center, a regional environmental education site, which partners with four K-12 school districts, 2 of which are identified as rural and one with over 51% minorities. He has directed K-12 teacher professional development, graduate level research, and facilitated field experiences for over 15,000 K-12 students. He is the Co-PI for the NSF funded Cultural Relevant Pathways to Environmental Science Literacy research grant in which he co-facilitated the Professional Development, and Case Study teams; member of the NASA funded Global Climate Change Education grant; both

focused on secondary Science education. **Dr. Matt Wallenstein:** Faculty member of the department of Ecosystem Science and Sustainability and research scientist of the Natural Resource Ecology Laboratory. Four of experience teaching and advising undergraduate students from freshman to senior level, and students on research projects.

**Adequacy of available or obtainable support personnel, facilities, and instrumentation**

**Colorado State University:** The education and training of young scientists (post-graduate - M.Sc., Ph.D.), students (graduate, undergraduate, K-12), K-12 teachers, natural resource managers, the public, and policy makers are important components of the mission of the new Department of Ecosystem Science and Sustainability (ESS established in 2011) and the Natural Resource Ecology Laboratory (NREL established 1967). Both the NREL and ESS are housed in the CSU Warner College of Natural Resources. ***The Department of Ecosystem Science and Sustainability (ESS):*** The ESS consists of 18 faculty members, all of who have joint appointments with the NREL. The department was formed in 2011 in recognition of the long history of ecosystem science at CSU and as part of a reorganization of the college. Currently the department offers a BS and MS in Watershed Science and a BS in Ecosystem Science and Sustainability. The BS in Watershed science degree was established over 50 years ago and represents one of the more prestigious degree programs of its type in the country. There are currently 83 students enrolled in the program. Students completing the BS in Watershed Science meet the criteria to qualify as a Hydrologist (job series 1315) for the federal and the Professional Hydrologist education requirements for the American Institute of Hydrology. The new BS in Ecosystem Science and Sustainability represents one of the first of its kind in the country. Currently there are 39 students enrolled in the program. We project enrollments of over 200 students within five years. ***The Natural Resource Ecology Laboratory (NREL):*** The NREL has

been recognized as a CSU Program of Scholarly and Research Excellence since the inception of the distinction in 1997. The NREL does not offer degree programs, but its scientists contribute to existing programs through advising graduate students (over 40 graduate students), the largest contributions going to the Graduate Degree Program in Ecology (GDPE), ranked in the top 5 of ecology programs by U.S. News and World Report. **Faculty and Scientists:** The faculty and scientists at ESS and NREL represents one of the most distinguished collections of ecosystem scientists in the world. Among our members, we include former presidents of the Ecological Society of America and the American Institute of Biological Sciences, program officers at the National Science Foundation, chairs and panel members to numerous National Academy of Sciences committees, fellows of scientific societies and panelists for funding agencies, and members of the UN IPCC – co-recipient of the 2007 Nobel Peace Prize. NREL scientists and students are the recipients of numerous honors and distinguished awards for their contributions to ecosystem science and education. Over the past five years the faculty and research scientists of ESS and the NREL produced a total of 521 papers, 56 chapters, and 9 books published. ESS and NREL scientists have an exceptionally distinguished record of publications in the world's premier journals covering general science, the environment, and ecology, such as *Science*, *Nature*, *Proceedings of the National Academies of Science*, *Bioscience*, *Ecology*, and *Ecology Letters*. Our scientists also have an exceptional record with respect to total publication numbers and citations, with several members, and the unit as a whole, ranking in the top 1% of scholars in disciplines within the environment and ecology and with h-indices from 25 to 60 (per Web of Knowledge) - levels deemed outstanding for their number of active years. **CSU Student Support Services and Programs:** Services include but are not limited to: 1) Recruitment of students to degree programs in ecosystem science and sustainability and watershed science; 2) Mentoring of

students by faculty scientists at the NREL and ESS, and student support service professionals from the Access Center; 3) Academic support in the form of tutoring, study-groups, or supplemental instruction programs provided during the *Summer Bridge Scholar Program*, *Freshman Key Learning Community*, and during their tenure in the degree program; 4) A coordinated plan to arrange internship opportunities and research opportunities. 5) Community building and support among WAMS fellows within the institution through the *Summer Bridge Scholar Program*, *The Key Learning Community*, the freshmen orientation, and departmental activities; 6) A plan to support the participation of WAMS fellows in local or regional professional meetings and conferences; 7) Seminars and career counseling and job placement activities within the department and college for S-STEM scholars. Additional descriptions of services are provided below. ***Professional Development - Transition to Graduate Education and Careers:*** The project leadership will work with the Career Center Liaisons that operate out of the Dean's office to provide WAMS fellows with group and individualized assistance in selecting and preparing applications to graduate school and for jobs in the public and private sectors. We are fortunate in that the Career Center Liaisons provide seminars and workshops on preparing CV's, GRE testing, letters of application, interview skills, and job placement. Students as a group will attend the seminars and workshops and work with their faculty mentors on an individual basis. WAMS fellows will participate in the CSU Alliance for Graduate Education and the Professoriate, and Summer Bridge Program seminars where we offer sessions on how to write a scientific paper, how to conduct successful research, available financial opportunities in the Graduate School, how to select a research topic, and how to select an advisor and a mentor. ***The Mentoring Strategy and Research Environment:*** The research and internship opportunities will focus on environmental change from a social-ecological perspective (Collins et al. 2011).

Colorado State University and the faculty and scientist within the Warner College of Natural Resources have a long history of collaborative research in the study of the shortgrass steppe starting with the International Biological Program (IBP) in the late 1960s. The group has a strong commitment to supporting summer Research Experience for Undergraduates, and with working with High School enrichment programs that serve first generation and low-income students, several of whom have been from under-represented groups. Our WAMS program will build on this record of interdisciplinary research. The Front Range of Colorado encompasses the Rocky Mountains east of the continental divide and a large portion of the Colorado Piedmont Section of the western Great Plains defined as the boundaries of the Central Plains Experimental Range managed by the Agricultural Research Service, and the Pawnee National Grasslands managed by the U.S. Forest Service. The CSU Pingree Park campus at 3000 m elevation and the CSU Shortgrass Steppe Research and Interpretation Center on the prairie frame multiple ecosystem types and major watersheds with state-of-the-art research facilities. Potential study sites are within an hour's drive of CSU, with shuttle service and on-site residences at these facilities for those that choose to work on site. The research laboratories and facilities at CSU are well equipped and staffed. ***Mentoring Strategy:*** We will adopt the apprenticeship model that involves immersing fellows into a community of scholars that includes undergraduates, graduate students, post-doctoral fellows and faculty that is led by a senior scientist. We will provide structured instruction through the career development and connection seminars. Fellows will receive direct training from senior scientists, and 'peer-mentors' (undergraduates and graduate students). In time, the fellows themselves become peer-mentors to new fellows. For this to work the faculty and peer-mentors will undergo a mentoring training program led by the leadership and campus support based on the "Entering Mentoring" program, from the Wisconsin Program for Scientific

Teaching and the National Academies Fellows in the Life Sciences mentoring program.

**The Centennial Board of Cooperative Education Services (BOCES):** The Centennial Board of Cooperative Educational Services (BOCES) is one of 19 BOCES authorized by the Colorado legislature to serve two or more school districts or a school district and a higher educational institution. Centennial BOCES is funded by participating member and non-member districts and from a combination of specific program grants and contracts from private, state and federal sources. The Centennial BOCES provides a variety of services to 13-member school districts with approximately 39,000 students across a geographical area of 5,853 square miles in Weld, Boulder, Morgan, Adams and Larimer counties. Services include Special Education, Technology Support, Alternative Teacher Licensing Program, Migrant Education and Services, Grant Writing, Early Childhood and Child Find Services, Online Learning, Homeless Education and Support, Student Information Systems, and Special Initiatives such as the proposed Northern Colorado WAMS.

**The Poudre Learning Center:** The Poudre Learning Center (PLC) is an educational and outreach facility for interdisciplinary learning focusing on the importance of history, science, economics, stewardship and aesthetics of the Cache la Poudre River and Northeastern Colorado. The PLC aims to be a keystone for the other learning opportunities along the Poudre River, showcase the importance of the Cache la Poudre River to the wildlife, vegetation, and agricultural/municipal uses it supports, provide outdoor classrooms in areas of natural, cultural, and economic significance, and establish habitats that are representative of this region of Colorado. The Poudre Learning Center develops and offers interdisciplinary education programs aimed at reinforcing concepts presented in local school curriculums.

**Adequacy of Plans for Management, Dissemination of Evaluation of the proposed project**

Table 3 provides an overview of the timeline of activities recruitment activities prior to admission, WAMS activities by year for a single cohort of students, and the personnel that are responsible for the activities. Dr. Moore will serve as PI. Dr. Boone, Dr. Conant, Dr. Felix, Dr. Kampf, and Dr. Wallenstein will serve as Co-PIs from CSU; Mr. Rangel from the Centennial BOCES, and Mr. Tschillard from the Poudre Learning Center. Dr. Moore (Director of the NREL and Head of the Department of Ecosystem Science and Sustainability) will be responsible for the overall management of the program and working with the campus administration to institutionalize the program. Dr. Conant will work with Dr. Felix (Access Center) to coordinate

Table 3. Management and Administration Timeline			
Goals	Activity	Timeline	Responsible Parties
<b>Program Goals</b>			
Goal 1&3	Recruitment Plan and Material Development Recruitment Visits	Fall 13 Spring 14	Bowser, Rangel, Moore - Leads PI's & Faculty- Support
Goal 2	Seminar Develop Establish Research and Internship Rotations Career Advising	Spring 13 Fall 14 Ongoing	Wallenstein – Lead Conant, Kampf, Tschillard – Leads Access Center, CASA, & ESS PI's, Faculty, Student Support
<b>Student Center Goals</b>			
Goal 4-6	Seminars Bridge Program Key Freshman Learning Community Freshman Orientation Research and Internship Rotations Teachers-in-Residence	AY Annually Summer 14-17 AY Annually Fall 14-17 AY Annually Annually	Boone - Lead Access Center/ESS– Felix/Conant Moore, Boone, Kampf ESS – Moore and Conant ESS – Wallenstein, PLC – Tschillard ESS – Moore, PLC Tschillard
<b>Institutional Goal 6</b>			
Goal 7	Faculty engagement with the Access Center Faculty engagement with Key Freshman Learning Communities	Ongoing	Felix and Moore - Leads
<b>Program Wide</b>			
All Goals	Project Administration PI meetings Project Evaluation	Ongoing Bi-weekly Annually	Moore & Blanken PI's & Sr. Personnel Metrica, Inc. - Shaw PI's& Sr. Personnel

the *Summer Bridge Scholar* and *Freshman Key Learning Community* programs. Dr. Kampf and Dr. Boone will be responsible for the coordination of the proposed academic and research components for the B.S. in Ecosystem Science and Sustainability and B.S. in Watershed Sciences, respectively. Ms. Nikki Blanken (Administrative Professional for ESS) will serve as the project coordinator in charge of scheduling, maintaining student records, assisting in evaluation and report preparation, and scheduling career development and professional seminars. Dr. Wallenstein will coordinate the development and offering of the proposed seminars the capstone courses for seniors completing their research. Dr. Gillian Bowser (NREL), Dr. Felix (Director of the Access Center), and Rangel (Centennial BOCES) will lead the recruitment efforts. Mr. Ray Tschillard (PLC) will coordinate the Teacher-in Resident program and the recruitment and Research Experience for Teachers program. All senior personnel will assist in recruitment, deliver the proposed workshops and seminars, and serve as research mentors.

**Project Assessment, Evaluation, Reporting, and Dissemination:** As noted in Section 2, Dr. Shaw (Metrica, Inc.) will serve as the external evaluator (*see* letter of commitment) with input from the project leadership for program assessment and evaluation. Dr. Moore will be responsible for coordinating the required project reporting to the USDA. Student presentations of their final research projects will be publicized throughout the university, encouraging broad dissemination of their work and engagement of the university community. We will develop a system for tracking program outcomes including rates of retention in degree programs and success in career placement. Each year, students will be given a survey assessing the program, and faculty participants will summarize program outcomes. Venues for dissemination include websites and social media sites, peer-reviewed journals, book chapters, and professional education-related conferences.