Focus Area 1: Biophysical Ecohydrologic System

Team (leaders in bold)

Zach Aanderud (BYU), **Michelle Baker** (USU), **David Bowling** (UU), Rick Gill (BYU), Jiming Jin (USU), **Scott Jones** (USU), Beth Neilson (USU), Diane Pataki (UU), Sam St. Clair (BYU), Court Strong (UU), Dave Tarboton (USU), Sue Walther (UVU)

Overarching Goal

Our goal is to improve Utah's capacity to monitor and understand the ecologic/climatic/hydrologic (hereafter ecohydrologic) system of the Wasatch Range Metropolitan Area (WRMA). We will achieve our goal by improving watershed-scale measurement capacities and by using this instrumentation to conduct research aimed at better understanding the biophysical processes that influence our water resources.

Guiding Research Questions

The original iUTAH proposal posed the following three research questions that will guide activities in this research focus area:

1. What is the water balance of forested, urban, exurban, and agricultural land cover?
2. What determines water quality?
3. How will availability of and demand for mountain water resources change as a result of climate and land use change?

General Approach

We will construct and operate an ecohydrologic observatory called GAMUT, which stands for Gradients Along Mountain to Urban Transitions. GAMUT will measure aspects of water inputs, outputs, and quality along a mountain-to-urban gradient in three watersheds that share common water sources (winter-derived precipitation) but differ in the human and biophysical nature of land-use transitions. GAMUT will allow for real-time monitoring of common meteorological variables, snow accumulation and melt, soil moisture, surface water flow, and surface water quality. Once GAMUT is functioning, research activities will be phased in to address our research questions. We recognize that GAMUT will not allow us to close the water balance in any one watershed; thus, our goal is to provide a sorely needed infrastructure platform to make Utah more successful in future large competitions for research funds.

Year 1 Goals, Activities, and Metrics

Goal 1: Enhance Utah's capacity to monitor ecohydrologic processes in the WRMA

> *Objective 1.1: Design GAMUT*
> - Define fundamental sensor units
> - Identify vendors for instrumentation
> - Identify locations for instrument installation
> - Design telemetry for integration of sensor data into the iUTAH Data Center

Metric: Instrumentation Plan for GAMUT (draft complete)

Objective 1.2: Build GAMUT
- Recruit and hire three technicians
- Purchase instrumentation
- Test instrumentation
- Negotiate MOUs with property owners for access to site locations
- Install instrumentation
- Develop standard operating procedures (SOPs) for instrument operation and maintenance

Metrics: Three successful hires (November 2012), instruments installed (July 2013), SOPs approved and in use (July 2013)

Goal 2: Enhance Utah's capacity to understand ecohydrologic processes in the WRMA
Objective 2.1: Begin to address research questions
- Develop sample analysis (data collection) plans

Metric: Sample analysis plans in place (July 2013)

Objective 2.2: Train Graduate Students
- Mentor students in writing successful fellowship applications
- Engage graduate students in watershed instrumentation plans

Metrics: Number of graduate students in research related to Focus Area 1 (five in 2012-2013), number of graduate student-led presentations (graduate students should be encouraged to present research at the 2013 Spring Runoff Conference)

Objective 2.3: Provide Undergraduate Research Opportunities
- Propose research themes/potential projects for Research Experience for Undergraduate (REU) students
- Match identified undergraduates to research mentors
- Conduct research in summer 2013

Metrics: Number of REU students and mentors in Focus Area 1 (summer 2013), number of presentations by REU students in Focus Area 1 (summer 2013)

Year 2 Activities

We will add instrumentation to GAMUT to allow monitoring of ecohydrologic processes at finer spatial scales in support of research identified by Focus Area 2; bring on additional faculty member in vegetation phenology (St. Clair); and conduct research and monitoring in three watersheds to be used in additional proposals.

Years 3-5 Activities

We will bring on additional faculty in ecohydrology (Gill) and climate modeling (Jin) to enhance research on vegetation and climate modeling scenarios; continue research and training activities; and submit interdisciplinary proposals and papers.

Focus Area 2: Social and Engineered Systems

Team (leaders in bold)

Faculty: **Daniel Bedford** *(WSU),* Martin Buehert (UU), Steve Burian (UU), Ryan Dupont (USU); Joanna Endter-Wada (USU), Sarah Hinners (UU), **Doug Jackson-Smith** (USU), Shujuan Li (USU), Carlos Licon (USU), **Christine Pomeroy** (UU), Charles Sims (USU), Carla Trentelman (WSU), Bo Yang (USU)

Graduate Students: A. Armstrong (USU), M. Burnham (USU), D. Houdeshel (UU), E. Li (USU), A. Odame (USU), K. Sandoval (UU), P. Stoker (UU), T. Walsh (UU)

Overarching Goal

Our work is designed to foster collaboration to improve the capacity of Utah's science community to gather and analyze social and engineering system data on coupled water systems in urbanizing and urban environments in the Wasatch Range Metropolitan Area (WRMA). We seek to better understand the interactions between urban form, environmental change, built water infrastructure, and water use and decision-making. Of particular interest is improving our knowledge about the impact of alternative infrastructure designs (including "green infrastructure") on the water cycle, water quality, and interconnected social and environmental systems.

Guiding Research Questions

Data collection and observatory infrastructure activities will be designed to enable us to better address the following three broad research questions outlined in the iUTAH proposal:

1. What are the current drivers of water and land use management in the region?
2. How does urban form interact with water availability?
3. How can we design our built systems to enhance water sustainability?

General Approach

We will gather systematic data on the built environment, water use behaviors and decisions, and institutional contexts across the larger WRMA, with particular focus and depth on areas within the three watershed observatories. We will coordinate with Focus Area 1 and Focus Area 3 to link social and engineering systems data to indicators of biophysical drivers and outcomes in coupled systems models. By collaborating with water system stakeholders and decision-makers, we want to ensure our data and models are realistic and useful to end users.

Year 1 Goals, Activities, and Metrics

Goal 1: Ensure our research activities produce data relevant to decision-makers

> ### Objective 1.1: Initiate collaborations with water system stakeholders
> - Conduct stakeholder focus groups in WRMA and watershed observatories
>
> **Metric:** Disseminate results of focus groups to full iUTAH team

Goal 2: Improve capacity of Utah scientists to study human dimensions of water systems

> ### Objective 2.1: Train graduate and undergraduate students
> - Involve graduate and undergraduate students in planning and research activities
>
> **Metric:** Number of student projects and presentations

Objective 2.2: Facilitate cross-disciplinary and cross-campus collaborations
- Support meetings and networking among social scientists, planners, and engineers
- Coordinate with ecohydrology science team to develop integrated research designs

Metric: Creation of integrated research plans

Goal 3: Ensure new social and engineering data can answer research questions

Objective 3.1: Identify candidate urban sites for intensive data collection
- Assess spatial data to identify clusters of neighborhoods with similar urban form
- Coordinate with Focus Area 1 to identify specific neighborhood sites for co-location of social, engineering, and biophysical data collection and monitoring activities

Metrics: Produce a map of neighborhoods by urban form type, select sites for future intensive monitoring and data collection

Objective 3.2: Assess availability of existing data in selected study sites
- Inventory and organize baseline data on built water infrastructure, sociodemographics, water institutions, and key decision-makers

Metric: Creation of common spatial database for each selected study site

Goal 4: Improve our capacity to collect intensive data about water use and water decision-making

Objective 4.1: Develop appropriate methods and instruments to document drivers of variation in water use behaviors
- Facilitate work groups to develop methods and instruments to collect data on actual water use behaviors and the drivers that shape water behaviors

Metric: Develop and approve research protocols for use in our study sites

Goal 5: Improve our knowledge of the built water infrastructure in our study sites

Objective 5.1: Begin inventory of built and green water infrastructure in Red Butte Creek and Logan
- Collect baseline data on water infrastructure from utilities and canal companies
- Find examples of green infrastructure to track pre- and post-implementation

Metric: Common spatial database of built water infrastructure

Goal 6: Improve our capacity to model water system outcomes related to built infrastructure

Objective 6.1: Develop methods to assess sustainability of current built infrastructure
- Define sustainability metrics for culinary, irrigation, storm water, and wastewater
- Assess range of infrastructure practices and regulations in larger region
- Evaluate alternative modeling approaches to simulate impacts of infrastructure and behavior on water system outcomes in urban environments
- Train graduate and undergraduate students to assess infrastructure impacts

Metrics: List of sustainability metrics for use in future assessments, proposed modeling approach to use in each study site, number of graduate student projects and presentations

Objective 6.2: Design and prepare to construct facility 2 on UU campus
- Refine design plans for bioretention and green roofs to be built at facility in Year 2
- Prepare to order appropriate equipment for facility

Metric: Detailed plan for implementation of facility 2

Years 2-5 Activities

We will continue to do the following:
- Work with the Education, Outreach, and Diversity team and our stakeholders to clarify water management challenges and assess appropriateness of our research design
- Finish collecting baseline data on social and engineering systems in study sites
- Implement ongoing monitoring of significant changes in population, land use, water infrastructure, and water use
- Collect new primary data on water behavior and drivers of water decision-making among individuals, households, and organizations in study sites
- Complete facility 2 and collect primary data to use in models to assess impacts of alternative built infrastructure designs on water cycle and water quality under a range of climate scenarios

Focus Area 3: Coupled Human-Natural System

Team (leaders in bold)

Diane Pataki (UU), Doug Jackson-Smith (USU), Reid Ewing (UU), Sarah Hinners (UU), Jeff Horsburgh (USU), Ryan Jensen (BYU), Chris Nelson (UU), Sara Null (USU), David Rosenberg (USU), Bo Yang (USU)

Overarching Goal

Activities in this focus area will draw on data and results from Focus Areas 1 and 2 as well as other ongoing work to study the linkages between the natural and human engineered water system. We will focus on activities that create centralized datasets across the social and natural sciences, coupled modeling activities, model-data comparisons, and model and data visualization for a variety of audiences.

Guiding Research Questions

Our original questions outlined in the proposal were as follows:

1. How can specific models representing hydrology, ecology, and human systems be coupled to ensure efficient exchange of inputs and outputs at appropriate spatial and temporal scales?
2. How can the coupled human-natural system cope with water resource changes?
3. How can we present and visualize our model and data products to enhance communication, learning, and experimentation among faculty, students, and stakeholders?

Year 1 Goals, Activities, and Metrics

Objective 1: Define and scope the coupled water system

- Develop a working conceptual model of the major water pools and fluxes within our study domain and identify the key processes and relationships that constitute the coupled human-water system
- Review the activities in Focus Areas 1 and 2 to determine whether additional processes, relationships, and datasets are necessary to understand the system as a whole. The temporal and spatial domain of the system will not be fixed, but it will be specified for each question of interest.

Objective 2: Create data inventory

- Work with the Cyberinfrastructure group to identify key datasets important to an iUtah data inventory and eventual data archive and clearinghouse. This activity will include identifying:
    - Common formats and metadata
    - Sharing agreements
    - Access control
    - Plans for long-term maintenance of time series datasets

Objective 3: Create model inventory

- Work with the Cyberinfrastructure group to identify relevant social and biophysical component models for iUtah currently used by iUTAH partners
- Explore existing and potential strategies for coupling models by specifying:

- o The temporal and spatial domain of each model
- o Inputs and outputs
- o Platforms

Objective 4: Link data to models
- Continue to specify and implement the areas where ongoing activities can be relatively easily linked to improve the representation of water processes in modeling studies that are already underway. Examples include:
  - o Incorporating more explicit information about water use and leaf area of local vegetation into climate models
  - o Adding vegetation scenarios to Envision Tomorrow+
  - o Linking urban form optimization activities and Envision Tomorrow+

Objective 5: Build collaborative relationships across campuses
- Facilitate interactions among individual scientists and science teams working at Utah universities to identify opportunities for data sharing, model improvements, and future collaborative research efforts

Years 2-5 Goals and Activities

1. **Scenario scoping**. We will develop a working group to consider the scenarios to be studied in Focus Area 3. Key questions include the following: How will we represent future land use change and decision-making? Will we develop common scenarios across all modeling activities? How/when will we include stakeholders in the development of scenarios?

2. **Evaluating water system change**. A key question for Focus Area 3 is about the response of the coupled water system to future change. We will focus our specific research questions on water system changes related to the impacts of:
   - Alternative urban forms
   - Implementation of green infrastructure
   - Climate change scenarios
   - Changes in population demographics and the implications for choices related to water use

3. **Coupled water models**. We will link models that individually represent specific aspects of the system such as hydrologic, climate, ecological, and agent-based models of decision-making. In the long-term (likely beyond the initial five-year grant), we seek to develop the iUtah Water Model that can be used to study the complex water system as a whole.

4. **Scoping and construction of the Environmental Situation Rooms**. The Environmental Situation Rooms are most closely linked to Focus Area 3. We will build two new visualization facilities, one at UU and one at USU, to display datasets and model outputs for interactions with team members, students, stakeholders, and the public.

Cyberinfrastructure

Team (leaders in bold)
Jeff Horsburgh (USU), **Steve Corbato** (UU)

Overarching Goal

Synthesis of diverse data collection and modeling requires creation of a facility with adequate storage, networking, computational, and human resources. Hardware, software, and data resources are already spread across the Utah universities. As such, we have proposed to build the iUTAH Modeling and Data Federation as a distributed facility that will support the full data life cycle, thus increasing capacity for data collection, organization, management, sharing, synthesis to higher level products, and integration with the proposed models. This facility will coordinate across Utah universities. For example, data organization, archival, and publication will primarily be supported at USU, whereas we will coordinate data storage resources with UU for redundancy and for High Performance Computing support. We will leverage development of enhanced optical network connectivity through Utah Education Network and the recent EPSCoR RII C2 award as well as computational resources through the recent Utah/Wyoming EPSCoR CI-WATER award.

Year 1 Goals and Activities

Specifically, the iUTAH Cyberinfrastructure team will conduct or begin the following goals and activities in Year 1. It is anticipated that many of these activities will extend beyond the first year of the project.

Goal 1: Hire part-time systems administrator, programmer analyst, and data manager

Goal 2: Scope, design, and deploy a virtual server architecture and data storage resources to serve as the platform for hosting the iUTAH Modeling and Data Federation
- Deploy production servers and an initial storage increment at USU
- Deploy backup services and storage at the University of Utah in collaboration with the Utah Track 2 EPSCoR CI-WATER project

Goal 3: Assist Focus Area 1 researchers in developing appropriate telemetry connections to iUTAH monitoring sites to facilitate automated retrieval of data

Goal 4: Develop databases, web services, and software that will:
- Support automated loading of streaming sensor data from iUTAH Focus Area 1 sites into databases within the iUTAH Modeling and Data Federation
- Provide access for data technicians working remotely to manage the quality assurance of the streaming sensor data from iUTAH field sites
- Support discovery of and access to the raw and processed data from iUTAH field sites

Goal 5: Support the activities of Focus Areas 1-3 by developing and conducting a survey of existing data needed by iUTAH researchers. Results will be used to prioritize datasets for inclusion within the iUTAH Modeling and Data Federation.

Goal 6: Based on the results of the data survey, prioritize and begin development of data services and/or mechanisms to provide access to datasets required by Focus Areas 1-3

Goal 7: Begin selection and/or development of appropriate standard formats and content for data and metadata that will be available through the iUTAH Modeling and Data Federation, including:
- Point time series (e.g., stream gages, weather stations)
- Geospatial datasets (e.g., shapefiles, rasters, images)
- Additional data types identified by iUTAH researchers

Goal 8: Support the activities of Focus Areas 3 through the identification of relevant models for iUTAH and the potential for coupling models

Goal 9: Begin development of a searchable metadata catalog for iUTAH data resources to support data discovery and retrieval

Goal 10: Begin development of partnerships with existing agencies, data providers, and cyberintrastructure development projects, including:
- Utah state agencies such as the Automated Geographic Reference Center (AGRC)
- Federal agencies such as the United States Geological Survey (USGS)
- The Utah EPSCoR CI-WATER project for data services and access to high performance capacity resources
- The Consortium of Universities for the Advancement of Hydrologic Science Hydrologic Information System project for access to streaming sensor data management software
- The Consortium of Universities for the Advancement of Hydrologic Science HydroShare project for data sharing and collaboration software
- The DataONE project for data archival software and services

Years 2-5 Goals and Activities
In subsequent years, the Cyberinfrastructure team will work on the following:
1. Using the input from other iUTAH research teams, continue prioritization and development of services for providing access to agency and national datasets as well as derived products developed by iUTAH researchers

2. Create mechanisms for adding data resources external to iUTAH to the searchable metadata catalog for iUTAH and/or mechanisms for federating data discovery across existing metadata catalogs

3. Develop necessary databases and cyberinfrastructure to support data from the green infrastructure facilities

4. Work with the Focus Area 3 team to develop data services, visualization, and modeling capabilities in support of the proposed Decision Theaters

5. Leverage existing relationships with the NSF-funded The Consortium of Universities for the Advancement of Hydrologic Science Hydrologic Information System and DataONE projects to support formal data publication and archival within the iUTAH Modeling and Data Federation

6. Leverage the results of the Utah Track 2 EPSCoR CI-WATER project to create better linkages between data and high performance computing resources. These linkages will include facilities for moving iUTAH data to computational resources to support simulations as well as capabilities for curating model outputs and sharing them within the iUTAH Modeling and Data Federation.

7. Leverage the work of the NSF-funded HydroShare project and work closely with the Education, Outreach, and Diversity team to create enhanced functionality for data/resource sharing and collaboration within an online collaboration environment

Facilities

Team (leaders in bold)
Jim Ehleringer (UU)

Overarching Goals

iUTAH will build five facilities for statewide use to improve research, workforce development, education, and outreach capacities within Utah. The facilities will be readily accessible to over 90% of the state's population, since these facilities will be located in or adjacent to the Wasatch Range Metropolitan Area.

Year 1-5 Activities

Activity 1: GAMUT - Climate and hydrologic monitoring network

To better understand the changing uses, roles, and dynamics of water, we will build a single integrated climate and aquatic monitoring network encompassing three distinct but complementary watersheds. Sensor monitoring sites will follow gradients from source water regions in three upper watersheds through urban(izing) of each lower watershed. The distribution of monitoring sites emphasizes the lower portions of the watersheds undergoing urbanization of in three watersheds emerging from the Wasatch Mountains. We propose to identify this integrated network as GAMUT – Gradients Along Mountain to Urban Transitions. Data from GAMUT will feed into the iUTAH Modeling and Data Federation. Instrumentation will be placed at fixed sites and mobile units will be available to access other locations within the broad watershed. This facility is constructed during Years 1-2.

Each of the three watersheds share common water sources (winter-derived precipitation) but differ in the human and biophysical nature of land-use transitions. Instrumentation will be installed at 5 locations in each watershed and will include terrestrial and aquatic sensors, paired (as appropriate) along a single river network where possible. From north-to-south, the GAMUT units are:

- The Bear River Tributaries (Logan River and Little Bear River) represent flows originating high in the Wasatch Mountains that in low elevation portions flow through urbanizing areas of Cache Valley (irrigated agriculture to urban transition).
- Red Butte Creek watershed represents flows originating high in the Wasatch Mountains that in low elevation portions flow through urbanized Salt Lake City.
- The Middle Provo River represents flows originating high in the Uinta and Wasatch Mountains that in mid elevations flows through urbanizing areas of Heber Valley (irrigated agriculture to urban transition).

Thus, our network represents three the three contrasting gradients of urban development typical of the western US: upper elevation valley being converted from agriculture to urban development (Heber Valley), lower elevation valleys being converted from agriculture to urban development (Cache Valley), and lower elevation valleys already converted to urban regions (Red Butte Creek).

Within the urban region of each watershed, an urban tower will be constructed with meteorological trace gas and eddy covariance measurement capacities.

Activity 2: GRIF - Green Infrastructure Research Facility
The Green Infrastructure Research Facility is the first of its kind in the nation, a 2-acre facility dedicated to research, training, and outreach related to various aspects of green infrastructure in urban habitats. These facilities include (a) bioretention swales, (b) GI roofing, (c) 2 artificial streams with mature vegetation, (d) permeable pavement, and (e) stormwater management capitalizing on an adjacent bus lot. The GRIF is located at the UU, and this facility is underway now. The iUTAH components will be constructed during Years 2-3.

Activity 3: Modeling Laboratory
The third iUTAH facility is a Modeling Laboratory of 25 workstations, server, front-room monitor associated with instruction, and a projection system. This facility will be located at the UU and will serve as a modeling environment for students and researchers associated with any and all iUTAH-related activities. The College of Architecture + Planning will provide the laboratory space and maintain the equipment. This facility will be constructed during Years 2-3.

Activity 4: Decision Theater
The fourth iUTAH facility is a Decision Theater, planned for Years 4-5 of the iUTAH project. Envisioned at the moment are two decision theaters, consisting of video wall screens, servers, and video controller. Decision Theaters are planned for Logan (USU) and Salt Lake City (Natural History Museum of Utah). These theaters will be designed to engage iUTAH faculty with external engagement opportunities and for iUTAH faculty to highlight visualization tools for research, teaching, and outreach. This facility is scheduled to begin construction in Year 3 and to be built during Years 3-5.

Activity 5: iUTAH Modeling and Data Federation
The iUTAH Modeling and Data Federation is a distributed facility that will support the full data life cycle, thus increasing capacity for data collection, organization, management, sharing, synthesis to higher level products, and integration with the proposed models. This facility will coordinate across Utah's colleges and universities. Data organization, archival, and publication will primarily be supported at USU, whereas the facility will coordinate data storage resources with UU for redundancy and support at the UU Center for High Performance Computing. This facility is scheduled to be constructed during Year 1.

Diversity Enhancement

Team (leaders in bold)

Janet Ross (Four Corners School), Carla Enders, USU-Eastern, Nancy Huntly, USU, Kathleen Hurd, SKCC, Susan Madsen, UVU, Anne Wairepo, UVU

Overarching Goals

Goal 1: Increase the institutional, individual, disciplinary, and geographic diversity of the STEM enterprise in Utah in order to address the water sustainability issues facing Utah and the Mountain West

Goal 2: Integrate diversity into all iUTAH activities

- iUTAH's strategy for diversity enhancement is focused on creating opportunities for women, Native Americans, Pacific Islanders, Hispanic Americans, and rural communities. We will use the proposed place-based watershed science and urban scenario modeling activities to engage students and teachers from diverse populations in discussions of water sustainability issues with cultural relevance to their communities.
- Members of the Workforce Development and Diversity Enhancement teams will recruit diverse populations of students from their institutions and communities for undergraduate fellowships, graduate research fellowships, and Summer Institutes. We will place special emphasis on recruiting from institutions with large enrollments of underrepresented students such as Title 1 schools, Salt Lake Community College, SUU, Weber State, and the USU regional campuses at Blanding and Vernal.
- iUTAH has strategically partnered with the Four Corners School (FCS) of Outdoor Education in Southern Utah, which has a long history of working with teachers and students from Native American and rural communities. Four Corners staff has developed curriculum for diverse K-8 audiences based on iUTAH's watershed Focus Areas, tested that curriculum across the region, and trained K-12 teachers in the newly developed curriculum. Councilman Herm Olsen on our Diversity Enhancement team is fluent in Navajo, has extensive experience with Utah's Native American communities, and will connect iUTAH researchers with diverse populations statewide.
- Of the currently identified iUTAH participants, 39% are women, 2% are Hispanic, and 1 is Native American; no Pacific Islanders or African Americans currently are identified. Our goal is to increase the participant diversity to 45% women, 5% Hispanic, 5% Native American/Pacific Islanders, and 5% rural combined.

Year 1 Activities

Activity 1: Diversify the members of the leadership team of the project, that is, invite people of the cultural groups above with skills and interests in this grant's focus to join the Education, Outreach, and Diversity team.

Activity 2: Host a diversity training workshop for its leadership members in 2012 after it has been expanded to be inclusive

Activity 3: Bring cultural knowledge into the common understanding of all leadership members and thus into all grant activities. This can be done in two ways.
1. Create a cultural knowledge workbook of readings for all
2. Host a conference in early 2013 of workshops and presentations about culturally appropriate teaching related to water/watersheds/ecosystems for the various cultural groups listed above. Combine it with the Four Corners School / Bioregional Outdoor Education Project conference that is held the first weekend of March at USU Eastern and that already focuses on culturally appropriate teaching for K-8th grades but expand it to K-16.

Activity 4: Conduct some grant activities/research/citizen science projects in southern Utah closer to the teachers/students the grant wants to serve

Activity 5: Conduct targeted recruitment for diverse audiences

Years 2-5 Activities

Activity 1: Host a second conference in 2014 of workshops on culturally appropriate teaching techniques related to water/watersheds/ecosystems for grades K-12. Combine it with the Four Corners School / Bioregional Outdoor Education Project conference, which is held the first weekend of March at USU Eastern

Activity 2: Conduct some grant activities/research/citizen science projects in southern Utah closer to the teachers/students the grant wants to serve

Activity 3: Create recruitment flyers for grants, jobs, or scholarships; distribute information to the proper places to notify appropriate people and alert them of opportunities, especially at USU Eastern; attend career fairs at USU Eastern and Vernal and also Dine College in Shiprock, NM, and Tsalie, AZ.

Activity 4: Implement student research and graduate research studies at USU Eastern and the Four Corners School.

Activity 5: Develop curriculum for diverse grades 9-12 audiences based on iUTAH's watershed Focus Areas, test that curriculum across the region, and train K-12 teachers in the newly developed curriculum

Activity 6: Recruit for museum partnership activities. Taking Learning Outdoors will recruit teacher participants from grades K-12 with emphasis on communities with underserved populations, including Title I schools and rural communities. Years 1 and 2 of the grant will primarily focus on urban audiences. Years 3-5l expand program reach into rural communities. Natural History Museum of Utah will also leverage its relationships in Native communities to promote iUTAH through appropriate programs and resources. In all cases, strategies for further encouraging women in the sciences will be employed.

Activity 7: Create an "ACCESS-like" statewide iUTAH program for Utah women that will promote the recruitment and retention of women in the sciences by providing ongoing mentoring, research opportunities, and a Summer Science program for incoming freshmen women.

External Engagement

Team (leaders in bold)
Madlyn Runburg *(NHMU/UU),* Jessica Anderson *(UEN),* Brian Greene *(USU),* Laura Hunter *(UEN),* Paul Husselbee *(SUU),* Karen Krier *(UEN),* Carlos Licon *(USU),* Becky Menlove *(NHMU/UU),* Nancy Mesner *(USU),* Lorie Millward *(NHMU/UU),* Nalini Nadkarni *(UU),* Louisa Stark *(GSLC/UU),* Sarah Young *(USOE)*

Overarching Goal

iUTAH External Engagement (EE) work is focused on participatory research, outreach, communication, and dissemination activities that engage key stakeholders and the general public in the work and outcomes stemming from Focus Areas 1, 2, and 3. EE activities will also support Workforce Development and Diversity Enhancement goals to support the development of a diverse, well-prepared STEM workforce and more scientifically literate public in Utah.

Guiding Research Questions

EE partners, in collaboration with the audiences to be served, will develop research-based resources, learning opportunities, websites, curricula, and other visual displays to engage participants in iUTAH and communicate research results. EE partners will work to understand:
1. How effective are EE activities in increasing EE audiences' understanding of complex problems, the application of data and strategies for incorporating uncertainty in learning, and planning processes?
2. What approaches generate meaningful and sustained engagement?

General Approach

EE partners will bring together researchers, educators, students, stakeholders, and policy makers to inform the design and development of EE activities. Mix methods will be used for both collaboration and evaluation of these efforts. Workforce Development and Diversity Enhancement goals will also be incorporated into the EE work.

Year 1 Goals, Activities, and Outputs

During the first year of iUTAH, the primary EE activities include planning and implementation of the Natural History Museum of Utah/University of Utah's (NHMU/UU) work with K-12 teachers through Taking Learning Outdoors (TLO) and Utah State University's (USU) Utah Water Watch (UWW) Citizen Science program.

Goal 1: Provide participatory iUTAH related research experiences to K-12 and public audiences
> ***Objective 1.1: Leverage existing UWW and TLO programs to align with iUTAH EE goals***
> - **Activity**: Refine UWW and TLO program goals and content to support relevant aspects of iUTAH research areas
>   **Output**: Documented program goals and activities highlighting iUTAH EE goal alignment
> - **Activity**: Identify goals and needs to advance UWW and TLO programs into Year 2
>   **Output**: List of activities and outcomes that inform goals and needs

Objective 1.2: Integrate iUTAH research into the planning and implementation of UWW and TLO programs

- **Activity**: Include iUTAH researchers; Education, Outreach, and Diversity team members; and community stakeholders in the planning and implementation of UWW and TLO programs
  Output: List of collaborators and collaborations
  Output: List of integration points of iUTAH research with UWW and TLO

Objective 1.3: Support Workforce Development and Diversity Enhancement goals

- **Activity:** Design recruitment plan for diverse audiences as described in iUTAH
  Output: Documented recruitment efforts, including strategies and outcomes

Objective 1.4: Support project evaluation efforts

- **Activity**: Participate in iUTAH evaluation activities
  Output: List of EE evaluation activities and outcomes
  Output: Documented participation in iUTAH evaluation activities

Goal 2: Develop dynamic communications strategy for dissemination of iUTAH activities and outputs
Objective 2.1: Produce an iUTAH website

- **Activity**: Design and launch iUTAH website
  Output: Fully functioning website in place
  Output: Established process for adding content and enhancements

Objective 2.2: Support project evaluation efforts

- **Activity**: Participate in iUTAH evaluation activities
  Output: List of EE evaluation activities and outcomes
  Output: Documented participation in iUTAH evaluation activities

Years 2-5 Activities

We will continue work with iUTAH research and Education, Outreach, and Diversity teams to further develop engaging programs and resources to meet EE goals. This includes refining EE work and expanding audience reach based on evaluation results. Work plans for Years 2-5 will be further developed during Year 1.

Workforce Development

Team Leads

Workforce Development Plans: Tami Goetz, UVU
Undergraduate Research Program: Brian Avery, Westminster
Summer Institute: Louisa A. Stark, UU
Internship Program: Bob Ramsey, Canyon Concepts; Chris Keleher, Utah Department of Natural Resources
iUTAH WEST (Water, the Environment, Science and Teaching): Holly Godsey, UU

Overarching Goal

Our goal is to enhance the STEM workforce in Utah by developing educational programs for a diverse range of learners that will inspire students to choose STEM careers, promote the retention of students in STEM degrees, and enhance the success of faculty in STEM disciplines.

Year 1 Goals and Activities

- **Undergraduate Research Program:** We will provide summer research opportunities for undergraduates to work jointly with iUTAH scientists and graduate students. We will place special emphasis on recruiting from primarily undergraduate institutions and those with high enrollment of diverse groups, since these institutions often lack the facilities, time, financial support, and opportunity to provide research experiences for students. Students will work in close supervision with iUTAH scientists and engineers and will be encouraged to develop their own research projects as they gain research experience. Undergraduates will be paired with near-peer mentors, either more senior undergraduates or graduate students, to enhance their research experience. The Diversity Enhancement team will assist with recruitment to ensure there is a diverse pool of iUTAH Research Experience for Undergraduates. In Year 1, students will be recruited, screened and selected for participation and matched with iUtah researchers at the University of Utah and Utah State University. A poster symposium will be hosted to showcase the results of the iUtah undergraduate research activities. The effectiveness of the program will be assessed and lessons learned will be applied to improve the program for the subsequent years.

- **Summer Institute:** The annual Summer Institute will bring together teams of students and teachers to work with iUTAH researchers at each of the watersheds being monitored. The external engagement portion of these institutes involves working with informal science educators to translate the research results into outputs for community use. Each team will develop either a digital or off-line product related to iUTAH research and targeted for subsequent museum exhibits or for formal education use. Resources developed by these Summer Institute teams will be disseminated through a number of different avenues, including exhibits at Natural History Museum of Utah and The Leonardo, the iUTAH web site, and the Utah Education Network. In Year 1, the institute team will begin planning for the summer of 2013 for the first Summer Institute. The planning process will focus on the first summer institute to be held at the University of Utah (summer 2013), but it will also include planning for the summer institute in 2014 to be held at a primarily undergraduate institution (PUI). The team will recruit instructors, researchers, and students as part of the work that will lead to the Summer Institute in 2013.

- **Internship Program:** An iUtah internship program will broaden science, technology, engineering, and math (STEM) education for Utah students by integrating knowledge and theory learned in the classroom with practical application of skills development in a professional setting. Internships will give students the opportunity to gain valuable applied experience and develop real-world perspectives of STEM-related fields they are considering for career paths. Similarly, internships will give prospective employers the opportunity to guide, mentor, and evaluate potential employee talent. To effectively implement the iUtah Internship Program, it will be necessary to establish goals, identify needs and opportunities, define the criteria for legitimate internships, establish scheduling requirements, develop protocols for implementation, and provide coordination and follow-up. In Year 1, the internship team will spend the majority of the time defining the criteria for the internship program such as duration, expectations, and recruiting and placement mechanisms. They will be recruiting company partners to offer sites for internships as well. The first cohort of interns will be placed during the summer of 2013.

- **iUTAH WEST (Water, the Environment, Science and Teaching):** The iUTAH WEST fellowship program will provide upper-division, science-focused undergraduate students the opportunity to learn critical communication skills while engaging K-12 students and teachers in learning about Utah's water resources. welve Fellows will be recruited from the University of Utah, Utah State University, and Utah Valley University to participate in the program. In Year 1, the team will focus on recruiting participants who will evaluate existing curriculum materials and write any additional materials that are necessary. Professional development activities will be developed and the first summer workshop will be offered the summer of 2013. Fellows will be recruited during Year 1 as well.

Years 2-5 Goals and Activities

- **Undergraduate Research Program:** In Year 2 and the subsequent years, the research program will be expanded to research participants at primarily undergraduate institutions (PUIs).

- **Summer Institute:** Year 2 will work with the next hosting location at a PUI to plan for the Summer Institute in 2014.

- **Internship Program:** In Year 2, the Year 1 process will be repeated and the student pool will be expanded to the PUIs.

- **iUTAH WEST:** Fellows will begin their mentoring activities in Year 2 and present their results in the summer of 2014. The cycle will be repeated and fellows and teachers will be recruited from PUIs and the summer workshop and mentoring activities expanded to PUIs.