Watershed Sciences Department

Pre-Project Symposium

Friday, March 30, 2007
Eccles Conference Center 205-207

Watershed Sciences Department
GRADUATE STUDENT
PRE-PROJECT SYMPOSIUM

College of Natural Resources
Utah State University
March 30, 2007

Welcome to the First Annual Watershed Sciences Graduate Research Pre-Project Symposium.

Today we will have the opportunity to hear from 19 M.S. and Ph.D. graduate candidates, as they present the ideas that will form the basis for their research during their tenure in our Department.

The students will not be at the same stage in their research development. Many are still thinking about how best to proceed; others have already determined how they wish to address their questions of interest. This diversity of talks you will hear reflects, in part, the many different approaches each is taking towards answering important water resource and conservation issues.

This is their chance to publicly present their ideas and request your feedback on how to improve their research. Remember, your comments and insights are welcome and, in one sense, expected.

Enjoy today's presentations, and please join us for the social that will follow.

1st Annual
WATERSHED SCIENCES
PRE-PROJECT SYMPOSIUM
College of Natural Resources, Utah State University
Eccles Conference Center, Rooms 205-07
March 30, 2007

Program Schedule

8:20	Welcome	Todd Crowl
SESSION 1	Moderator	Dave Cole, PhD Candidate
8:30	Ben Nadolski	Factors Influencing Brook Trout and Bonneville Cutthroat Trout Distribution in the Mill Creek Drainage, Utah
8:45	Jeremiah Wood	The Role of Brown Trout in a Native Cutthroat Trout Stream: Spawning Ecology, Early Life history, and Predation Potential
9:00	Brian Hines	Understanding the Complex Life History Ecology of a Lacustine Sucker for Conservation and Management
9:15	Kevin Landom	Size-dependent Prey Vulnerability of the Endangered June Sucker (*Chasmistes liorus*) to a Nonnative Piscivorous Fish Community
9:30	Christy Meredith	Predicting Success of Cutthroat Trout Populations Using Estimates of Geomorphic Complexity Within River Networks
9:45	BREAK	
SESSION 2	Moderator	Stephen Bennett, PhD Candidate
10:15	Molly Van Appledorn	Watershed-Scale GIS Analysis of Riparian Buffer Function in the Lower Peninsula of Michigan
10:30	Amy Burke	Hillslope-Stream Connectivity in Aspen and Conifer Stands in Northern Utah
10:45	Amanda Schulz	Effect of Hillslope Hydraulic Connectivity on Nutrient Concentrations at a Watershed Outlet
11:00	Andrew Hill	Assessing the Relationship Between Stream Condition and Broad Scale Watershed Characteristics
11:15	Ryan Lockwood	Stream/Lake Interactions in Nitrogen Cycling in Alpine Ecosystems

11:30	LUNCH	ON YOUR OWN!
SESSION 3	Moderator	Ryan Hill, PhD Candidate
1:00	Cody Johnson	Landscape Control of Arctic Lake Nutrient Cycling and Limitation Through Consumer Driven Nutrient Recycling
1:15	David Dean	Hydrologic, Geomorphic and Ecologic Changes of the Lower Rio Grande in Big Bend National Park, TX
1:30	Jason Alexander	Coupling Historical and Modern Measures of Channel Adjustment to Understand the Potential Effectiveness of Hydrologic Restoration Techniques in the Upper Green River, Colorado
1:45	Susannah Erwin	Development of a Bed Load Budget for the Snake River in Grand Teton National Park
2:00	Priya Ganguli	Geomorphic and Geochemical Influences on Mercury Transport and Fate
2:15	BREAK	
SESSION 4	Moderator	Brian Creutzburg, PhD Candidate
2:45	Gabe Bissonette	A Remote Phenological Approach to Monitoring Semi-Arid Vegetation Rehabilitation Using Remotely Sensed Data
3:00	Simon Bisrat	Application of MODIS Satellite Imagery to Solve Critical Land/Resource Management Problems in Western United States Forests and Hawaii
3:15	Melissa Hamar	Interpreting 250m Moderate Resolution Imaging Spectroradiometer Vegetation Indices in the Colorado Plateau, USA
3:30	Martin Buchert	Continuous Field Vegetation Classification of a Sagebrush (*Artemesia spp.*) Dominated Ecosystem Using High Spatial-Resolution, Multi-spectral Satellite Imagery

6:00 : **Social at Chris Luecke and Nancy Mesner's Home**
Heavy Hors d'oeuvres - 198 S 200 E, Providence

Ben Nadolski

Factors Influencing Brook Trout and Bonneville Cutthroat Trout Distribution in the Mill Creek Drainage, Utah

Advisor: Dr. Phaedra Budy

Through well-documented competitive interactions, invasive brook trout (*Salvelinus fontinalis*) are implicated as a primary factor leading to the decline in distribution and abundance of native cutthroat trout (*Oncorhynchus clarkii*). It is thought that cutthroat trout are less likely to co-exist with brook trout than any other trout species. Typically, when brook trout are introduced into non-native habitats, they quickly invade and become established, ultimately impacting native trout through reduced growth, condition, and ultimately fitness. However, based on spatially explicit patch occupancy data, it appears that brook trout are patchily distributed throughout portions of the Mill Creek drainage and have not invaded nearby tributary streams, despite no apparent physical or biological barrier. The purpose of my research is to determine the factor(s) that influence the relative distribution of brook trout and Bonneville cutthroat trout (*Oncorhynchus clarkii utah*) in the Mill Creek drainage. To accomplish this, I will collect a suite of biotic and abiotic data from ten representative index sites throughout the drainage. Additionally, at each index site, I will conduct three-pass depletion electroshocking surveys to determine fish species composition and relative abundance, as well as a comprehensive presence/absence survey of fish distribution throughout the study area. These findings will enable managers to prioritize cutthroat trout management actions in the Mill Creek drainage, and are important for range-wide cutthroat trout conservation activities. Additionally, the information obtained from this study will be useful in determining why brook trout are successful invaders in some systems, yet, remain in low and patchy abundance in others.

Jeremiah Wood

The Role of Brown Trout in a Native Cutthroat Trout Stream: Spawning Ecology, Early Life History, and Predation Potential

Advisor: Dr. Phaedra Budy

The introduction of exotic fish has proven detrimental to the persistence of native trout populations throughout the intermountain West. In the Logan River, Utah, brown trout (*Salmo trutta)* outcompete native Bonneville cutthroat trout (*Oncorhynchus clarkii utah)* when the two species exist in sympatry, but the factors that determine brown trout distribution, and thus limit these competitive interactions, remain unknown. My goal is to better understand the role of brown trout spawning ecology and early life-stage survival in determining spatial extent and distribution. I will accomplish this goal through four main objectives. I will conduct spawning surveys throughout the fall and winter to document the timing, intensity, and distribution of brown trout spawning throughout the Logan River. To better understand how conditions might limit brown trout in the early life stages, I will evaluate egg to fry survival of brown trout eggs along an altitudinal gradient in the river. I will assess the potential of brown trout to prey on juvenile cutthroat trout by collecting adult brown trout and quantifying their diets at different times of year. Finally, I will conduct a literature review/ meta-analysis to gain a better understanding of the factors that limit brown trout distribution in streams throughout both their native range and areas where they have been introduced. Understanding the mechanisms that limit brown trout distribution, and their potential to prey on juvenile cutthroat trout , within the Logan River will allow us to predict the potential for these fish to expand their range and impact native cutthroat trout abundance and viability both in the Logan River and ultimately throughout the West.

Brian Hines

Understanding the Complex Life History Ecology of a Lacustrine Sucker for Conservation and Management

Advisor: Dr. Todd A. Crowl

The federally endangered June sucker (*Chasmistes liorus mictus*) is a planktivorous sucker endemic to Utah Lake. They are known only to spawn in the Provo River (the largest tributary to Utah Lake), but data collected during the summer of 2006 revealed that June suckers were present at the mouths of other smaller tributaries during spawning. Due to the lack of individuals and the complexity of the system, little is known about their life history. Understanding this life history is a key component to this species' recovery. I will identify the cues that these suckers use to find and move into the tributaries in which they spawn. This will be done using a variety of methods in three Utah Lake tributaries (American Fork, Battle Creek and Spring Creek) from April-July. We will couple tributary use data with water chemistry (DOC, pH, temperature, oxygen, alkalinity) and discharge data and use multiple regression and CART models to identify the cues used that draws these suckers to certain tributaries to spawn. The knowledge gained from this study will allow us to have a better understanding of the life history of the June sucker and eventually help in the recovery of an endangered species.

Kevin Landom

Size-Dependent Prey Vulnerability of the Endangered June sucker (*Chasmistes liorus*) to a Nonnative Piscivorous Fish Community

Advisor: Dr. Todd A. Crowl

Successful introductions of nonnative piscivores have altered native fish species biodiversity and richness in many North American water bodies. In numerous cases, predation by introduced piscivores has resulted in local extinction of native fishes; an increasing body of evidence suggests native fish morphology is directly associated with local extinction risk. Piscivores must swallow their prey whole, making the relationship between piscivore gape width and prey body size the functional limitation for predator-prey interactions. Shallow-bodied native species appear to be most at risk to local extinction via nonnative piscivory, due to an extended size-dependent vulnerability window to predators.

The June sucker (*Chasmistes liorus*), is endemic to Utah Lake, UT, and federally listed as an endangered fish with critical habitat. The successful introduction of nonnative piscivores is considered a major impediment to recovery of the June sucker. Our goal is to develop a predator-prey model that will assist in estimating the affect of predation by nonnative fishes on June sucker survival. Recognizing the June sucker is a shallow-bodied species, it is essential to identify the size-dependent vulnerability of the prey population, and include the temporal component of vulnerability in a predator-prey model.

Christy Meredith

Predicting Success of Cutthroat Trout Populations Using Estimates of Geomorphic Complexity Within River Networks

Advisor: Dr. Matthew E. Baker

Tributary confluences have long been considered important sites of disruption along gradual ecological gradients described by the River Continuum Concept. Confluences provide discontinuities in downstream processes through fluxes of water and sediment that can have both proximate and farther-reaching effects on channel and floodplain morphology. Recent studies have suggested that the structure of the drainage network, including the arrangement, density, and local geometry at confluences, may help explain patterns of habitat heterogeneity for aquatic organisms. Further, the variance in habitat types created by confluences may be directly related to the flux and size of sediment between convening tributaries. However, to date, few studies have addressed the importance of geomorphic complexity resulting from confluence effects in creating habitat for any one species or community throughout a river network. This study will estimate geomorphic complexity within watersheds of the Bear River Drainage by examining variance in physical parameters measured from longitudinal and cross-sectional profiles and resulting temperature changes due to hyporheic exchange. Field measurements at confluences and between confluences will be related to parameters estimated remotely using Digital Elevation Models and aerial imagery in order to develop predictions of geomorphic complexity in other portions of the study watersheds. A hierarchical data model will be used to relate estimates of geomorphic complexity to patterns of Bonneville cutthroat trout (*Oncorhynchus clarki utah*) abundance and network structural attributes. This species has been found to rely on the quantity and quality of scour pool and water temperatures potentially regulated by hyporheic flux, and may therefore be impacted by both flow and sediment alterations amplified at confluences. By determining the importance of tributary junctions relative to other factors in providing geomorphic complexity throughout a river network, this study will develop expectations about how changes in hydrology or sediment flux at confluences could alter habitat for Bonneville cutthroat trout as well as other aquatic species.

Molly Van Appledorn

Watershed-Scale GIS Analysis of Riparian Buffer Function in the Lower Peninsula of Michigan

Advisor: Dr. Matthew E. Baker

Riparian buffer zones have the potential to filter undesirable nutrients from source land before they enter the stream, and as a result, are a priority for land management. Newly-derived metrics offer a conceptual advantage over previous methods of buffer quantification that base potential buffer function on the spatial distribution of contiguous vegetated area along flow pathways. The purpose of this study is to test the following hypotheses regarding the application of these flow-path metrics to a new landscape: 1) flow-path metrics are better descriptors of buffer function than previous methods, 2) flow-path metrics improve predictability of nutrient discharge compared to previous methods, 3) changes in land-use patterns over time result in decreased potential for buffer function, 4) an alternative flow-direction algorithm will more precisely define spatial relationships within the landscape, and 5) restoration strategies that are guided by flow-path analyses will reduce nutrient loads more cost-effectively than opportunistic strategies. I will test these hypotheses with 141 study watersheds in Michigan's Lower Peninsula using nitrate data collected by the Michigan Rivers Inventory project and publicly available elevation, land cover, and stream maps. I will incorporate published data on the effects of restoration practices to simulate nutrient discharge responses from targeted vs. opportunistic management approaches. The results of my analyses will be helpful in understanding the effects of local processes within the context of broader land-use patterns and will facilitate in the creation of restoration tools for riverine management.

Amy Burke

Hillslope-Stream Connectivity in Aspen and Conifer Stands in Northern Utah

Advisor: Dr. Tamao Kasahara

Mountain headwater catchments in the semi arid intermountain west are important sources of surface water because these high elevations receive more precipitation than neighboring lowlands. The hydrology of these catchments is especially important as the region faces water shortages and conflicts. Conifer encroachment on aspen stands has been noticed across the western US and can result in a decline in water yield. The overall objective of this study is to further our understanding of hillslope-stream connectivity in a headwater catchment of Northern Utah and any possible effects on it by conifer encroachment including a decline in runoff generation. The fundamental watershed unit is the hillslope. Therefore understanding processes on the hillslope scale is pertinent to managing valuable water resources. However hillslope hydrology is understudied in the snow-driven, semi-arid west, leaving a gap in our knowledge of how watersheds function. This study will help fill that gap by gathering information on how and when hillslope water connects to stream water. Our specific objectives are (1) determine if soil moisture shows an organized pattern, in relation to landscape position, surface topography, distribution of vegetation and soil profiles, (2) examine seasonal pattern of hillslope-stream connectivity, (3) find any soil water potential thresholds at which subsurface flow begins (4) compare subsurface flow between vegetation/soil types. Nests of soil moisture probes have been installed in transects on hillslopes adjacent to a stream in the headwaters of the Ogden River. One transect lies in an aspen dominated stand and the other in a conifer stand. Soil moisture sampling will also be expanded in a grid to capture spatial patterns during the spring snowmelt. These data, along with peak snow accumulation measurements, stream gauging and weather data will provide insight into hillslope processes. A trench will also be dug on each hillslope to quantify subsurface lateral flow leaving the hillslope.

Amanda Schulz

Effect of Hillslope Hydraulic Connectivity on Nutrient Concentrations at a Watershed Outlet

Advisors: Drs. Matthew E. Baker and Helga Van Miegroet

Saturated areas of a watershed are more likely to quickly transmit nutrients to the outlet. The flow paths of nutrients in the landscape may be determined by saturated areas that are hydraulically connected, creating a preferential flow path network. Previous work in the Noland Divide Watershed in the Great Smoky Mountains National Park showed temporal and volumetric variability in nitrate export compared to nitrate import. The lack of synchronicity could be explained by temporal patterns in nitrate production on the one hand, and precipitation/flushing on the other hand. This study seeks to determine how proximity to preferential flow paths in the landscape influences the concentrations of nitrogen at the watershed outlets. Geographic Information Systems (GIS) will be used to spatially represent the watershed and the preferential flow paths in it as well as to determine the importance of distance to the preferential flow paths. It is expected that the influence of the preferential flow paths through the landscape on the nitrogen concentrations at the outlets will be influenced by expanding and contracting source areas.

Andrew Hill

Assessing the Relationships between Stream Condition and Broad-Scale Watershed Characteristics.

Advisor: Dr. Matthew E. Baker

The conditions of aquatic and riparian resources are influenced by the complex interaction of physical and biological processes taking place at different spatial and temporal scales. Recognition of aquatic systems as a product of the surrounding landscape has served as a basis for scientific investigation into the relationships between watershed characteristics and the stream environment. Currently, there is a limited understanding of how broad-scale watershed characteristics influence habitat conditions for listed fish species. The purpose of this study is to determine how broad-scale watershed characteristics influence habitat conditions at the reach scale. I hypothesize that watersheds with similar characteristics (i.e. geology, climate and hydrology) will have similar habitat conditions. Differences in habitat condition between similar watersheds can be explained by the location and scale of natural and anthropological disturbance in the watershed. My study area will include 160 watersheds located throughout the Interior Columbia River basin. Habitat data have been collected for each of these watersheds by the U.S. Forest Service's PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Program. Watershed metrics derived from Digital Elevation Models (DEMs) and land cover data for each watershed will be analyzed to assess the relationship between broad-scale watershed characteristics and habitat condition. I expect to find significant relationships between broad-scale watershed characteristics and habitat condition are expected to be found. These relationships may be used to develop a predictive model for watershed assessment and could be applied directly to regions outside my study area.

Ryan Lockwood

Stream/Lake Interactions in Nitrogen Cycling in Alpine Ecosystems

Advisor: Dr. Wayne A. Wurtsbaugh

The presence of a lake in a watershed can influence downstream water chemistry and biology. This study will examine lake nitrogen cycling and the downstream effects of lake N-processing in Bull Trout Lake (Sawtooth Mountains, Idaho, USA). In 2006, mesocosms and a stable isotope addition (15N-NO3-) were used to quantify fluxes of dissolved organic nitrogen (DON) from the littoral zone sediments into the water column. Increases in DON concentration were measured both in the experiment and in the lake. The movement of 15N into the benthos along with a 200x greater chlorophyll concentration in the benthos vs. the pelagia suggests that the benthic zone biofilm community plays a predominant role in the nitrogen cycling of shallow oligotrophic lakes. In 2007, sediment core incubations will be used to model net nitrogen exchanges between the benthos and pelagia. A model of fluxes can be assembled by sampling the benthos along spatial and temporal gradients. This model can then be compared to observed patterns of nitrogen import and export from the lake. Another goal of 2007 is to compare the uptake of dissolved N-compounds (e.g. nitrate, ammonia, urea) to inflow and outflow biofilm communities. Inflow communities inhabit an environment where much more of the nitrogen is in an inorganic form vs. the environment of the outflow communities. The outflow communities may be better adapted to utilizing organics, such as those produced in the lake. The size class of the lake-produced organic compounds may be able to be measured by using isotope labeling of a mesocosm water column and ion-exchange resins that selectively remove nitrate and low molecular weight organics. Lower molecular weight organics have been demonstrated to be generally more bioavailable. Further, if separation of a labeled DON pool is possible then these compounds can be used in bioassays to examine biofilm utilization of DON versus inorganics.

Cody Johnson

Landscape Control of Arctic Lake Nutrient Cycling and Limitation Through Consumer Driven Nutrient Recycling

Advisor: Dr. Chris Luecke

Presence, absence, and composition of a fish community is controlled by landscape geomorphology in Arctic Alaskan lakes. Fish in this area exert strong top-down controls on lake food webs, and subsequently lake trophic structure is predictable from landscape variables. However, how fish structured food webs affect lake nutrient cycling and limitation is not understood. Consumers can affect nutrient cycling in lakes through the consumption of organic nitrogen and phosphorus (N & P), conversion of N & P from organic to inorganic forms, and excretion of labile ammonium and phosphate (NH4 and PO4). Conversely, consumers can also reduce available nutrients through secondary production by sequestering N & P as new tissue. The impact of consumers on lake nutrient cycling is dependent on whether nutrients are recycled (consumed and excreted in the same habitat) or translocated (consumed in one habitat and excreted in another), productivity of consumers, and stoichiometric relationships between consumers and food resources. Fish have the ability to affect lake nutrient cycles either directly by transporting N & P across large distances or directional gradients, or indirectly through top-down control of biomass and community composition of lower trophic levels. For my dissertation I propose to elucidate how consumers impact nutrient availability in Arctic lake ecosystems, and to determine if patterns of lake primary productivity and nutrient limitation are predictable based on landscape variables that control fish distribution.

David Dean

Hydrologic, Geomorphic and Ecologic Changes of the Lower Rio Grande in Big Bend National Park, TX

Advisor: Dr. John C. Schmidt

Over the past century, large scale water development on the upper Rio Grande in the U.S. and Mexico and on the Rio Conchos in Mexico resulted in major reductions in stream flow of the lower Rio Grande in Big Bend National Park (BBNP). Past studies indicate that reductions in hydrology may result in major channel responses including channel narrowing, channel aggradation, development of inset floodplains and the disconnection of the floodplain from the channel. Additional effects may include increased populations of riparian vegetation, the invasion of non-native riparian vegetation, degraded aquatic habitat and a decline in the quality of recreational boating.

The geomorphic and ecologic changes described above pose a direct risk to the health of the Rio Grande ecosystem within BBNP. Currently, the National Park Service (NPS) is conducting river rehabilitation and restoration projects within BBNP. However, riverine restoration and the reversal of the impacts described above are difficult because the underlying causes of the geomorphic and ecologic changes are beyond the control of the NPS. In order to define restoration targets, a clear understanding regarding hydrologic changes, the trajectory of channel change, the relationship between channel changes and riparian vegetation, the processes of sediment transport and bank erosion, and the combined effects on aquatic habitat is necessary.

In an attempt to further understand these relationships, the proposed study includes the following activities. Analysis of discharge measurement notes collected at specific locations to compare historic and current channel geometries. Analysis of floodplain stratigraphy and dendrogeomorphic analysis of inset floodplain deposits to reconstruct the timing and magnitude of floodplain accretion and channel narrowing. Field mapping of geomorphic surfaces, aerial photograph analysis and comparisons of historical oblique photographs to analyze past and present channel characteristics such as plan form, channel width and sinuosity over a broad spatial area.

Jason Alexander

Coupling Historical and Modern Measures of Channel Adjustment to Understand the Potential Effectiveness of Hydrologic Restoration Techniques in the Upper Green River, Colorado

Advisor: Dr. John C. Schmidt

Channel narrowing in the Green River below Flaming Gorge Dam been well documented. Sedimentation of channel environments has caused degradation of rearing habitat important to the four federally protected species endemic to the Colorado River system. The details of these channel changes have not been addressed in previous work due to the spatial and temporal limitations of the methods. The details of the hydrologic events responsible for channel narrowing are important to managers seeking channel restorative solutions, such as the use of pre-dam magnitude flooding to rehabilitate aquatic habitat. We propose to use high resolution dendrogeomorphic techniques to interpret the timing and magnitude of sediments deposited at four locations within Browns Park and Lodore Canyon. In addition, we will use the geometry of cross sections positioned throughout these reaches to expand the scope of our observations beyond those four sites and to observe channel behavior and adjustment to restorative floods. By combining historical and modern observations of channel response to specific flood magnitudes, we provide a basis for understanding the potential effectiveness of restorative flood tools.

Susannah Erwin

Development of a Bed Load Budget for the Snake River in Grand Teton National Park

Advisor: Dr. John C. Schmidt

Jackson Lake Dam (JLD) has regulated the flow of water from Jackson Lake reservoir to the Snake River in Grand Teton National Park (GTNP) since construction of the original dam in 1906. Regulation of the Snake River has resulted in marked changes from the natural hydrology of the watershed. However, the Snake River in GTNP is distinct from many other river systems impacted by dams in that JLD disrupts the flow of water, but not the flow of sediment to the Snake River. Channel form and behavior are determined by the amount and timing of sediment delivered to the river and the ecological community is inextricably linked to these physical processes. Qualitative observations indicate that delivery of bed material from tributaries may exceed the capability of the main-stem flows to transport the material downstream. Impacts of these sediment surplus conditions may include increased rates of channel avulsion, braiding, and bed aggradation near tributary mouths. Such changes can directly affect the aquatic and riparian communities along the Snake River. In an effort to better understand and assess changes in channel form and habitat impacts resulting from JLD operations, I am constructing a sediment budget for the Snake River in GTNP. Constructing a sediment budget involves describing the import, transport, storage and export of sediment from a river system. To quantify sediment inputs, I measured bed load transport rates on two large tributaries to the Snake River over a range of discharges in the spring and summer, 2006. I used these measurements to calibrate bed load transport relations for both tributaries and have estimated the amount of sediment delivered to the Snake River during the past 60 years. Measurements of bed load transport rates collected during the 2007 field season will be used to calibrate main-stem Snake River transport relations. With these data it will be possible to identify discharges necessary to maintain equilibrium flux of tributary-derived bed material downstream through GTNP.

Priya M. Ganguli

Geomorphic and Geochemical Influences on Mercury Transport and Fate

Advisor: Dr. John C. Schmidt

More than 400,000 stream miles in the United States are listed as impaired due to mercury contamination. Discharge from inoperative mine sites is a primary source of mercury to watersheds in California, where both mercury and gold were mined extensively. Remediating mercury-impacted habitats is challenging because of the complex biogeochemical behavior of mercury. Anaerobic bacteria can methylate mercury, transforming inorganic mercury into an organic form that is a potent neurotoxin capable of biomagnifying in the food web. Even trace quantities of mercury in water and sediment can potentially result in orders of magnitude higher concentrations in biota. The vast majority of mercury in surface water is particle-bound and transported with the sediment load of streams. To develop successful watershed remediation strategies, researchers and land managers must weave together the complex interactions between physical processes that drive sediment distribution and biogeochemical controls on mercury methylation and accumulation. Our study will focus on the Walker Creek watershed in northern California. Walker Creek, the second largest tributary to Tomales Bay, has been impacted by hundreds to thousands of kilograms of mercury discharged from an inoperative mine site. Tomales Bay, located in the Gulf of the Farallons National Marine Sanctuary, provides critical winter habitat for migratory waterfowl. Elevated mercury concentrations in biota reflect enhanced mercury uptake in this watershed. Remediation efforts at the mine site, completed in 1999, significantly reduced the discharge of contaminated sediments from the source. However, over-bank and floodplain deposits along Walker Creek and the intertidal mudflats in the Walker Creek Delta are potentially storing much of the historically released mercury. Our primary study objectives are to (1) define the distribution of mercury-laden sediments in the riparian corridor of the Walker Creek watershed (non-estuarine), (2) assess which areas pose the greatest risk of erosion given the current climate and flow regime conditions, (3) estimate mercury methylation rates in biologically critical habitat (e.g., riparian wetlands, backwater channels), (4) propose a restoration plan that will enhance habitat without exacerbating methylation potential, and (5) propose post-restoration evaluation criteria. Scientists in the field of stream restoration are grossly lacking data that allow holistic evaluations of post-project success: well-defined restoration goals combined with appropriate pre- and post- restoration assessments. Our study provides a unique opportunity to bring science into a stream restoration project from its inception.

Gabriel Bissonette

A Remote Phenological Approach to Monitoring Semi-Arid Vegetation Rehabilitation Using Remotely Sensed Data.

Advisor: Dr. Michael A. White

The 2002 Rattle Fire Complex (RFC) contains 94,519 acres of burned semi-arid landscape in the Book Cliffs. An interagency Burned Area Emergency Response (BAER) Team assessed the ecological damage and concluded that the application of seeding treatments was justified. Monitoring Emergency Stabilization and Rehabilitation (ESR) treatment effectiveness and vegetative rehabilitation during the first two years is of ecological and managerial interest to BLM land managers.

The purpose of this study is to monitor treatment effectiveness using remotely sensed metrics of plant phenology, community structure, fractional cover (FC) combined with a traditional ground sampling approach. Remote sensing, Geographic Information Systems (GIS), and field (in-situ) measurements will be integrated in an attempt to spectro-phenologically delineate vegetative growth forms and the emergence, establishment, and 2-year trend of vegetation development on these ESR projects.

Vegetation within the Cottonwood and Diamond watersheds of the RFC will be examined using a time-series of 2.4 meter multispectral and 60 cm panchromatic Quickbird imagery. A time-series of the Normalized Difference Vegetation Index (NDVI) and change-NDVI will be used to monitor phenological development. Structural vegetation change will be monitored using a time-series of FC using the NDVI* method. A field campaign will be designed to validate and interpret the satellite data, provide data for a cheatgrass cover linear regression model, and act as a stand-alone analysis.

Simon Bisrat

Application of MODIS Satellite Imagery to Solve Critical Land/Resource Management Problems in Western United States Forests and Hawaii

Advisor: Dr. Michael A. White

Remotely sensed datasets are being increasingly used in solving critical ecological problems. As an application of this scientific approach, we will use MODIS (Moderate-Resolution Imaging Spectroradiometer) products in two land/resource management problems. One project investigates the interactions between bark beetle damage and fire occurrence in western United States national forests. Under this project, we will use MODIS fire product (MOD14A2, 1km, 8-day composites) and aerial detection survey polygons for bark beetle damage. We will then use a conditional probability model to test the hypothesis whether there is an increased probability of fire incidence in bark beetle damaged forests compared to healthy forests in a spatially-explicit framework. The second project will deal with predicting the invasion potential of a Puerto Rican frog in Hawaii. Under this project, we will use three MODIS products for both Hawaii and Puerto Rico (2000-2005): land surface temperature (MOD11A2, 1km, 8-day composites); normalized difference vegetation index and enhanced vegetation index (MOD13Q1, 250m, 16-day composites); and leaf area index/fraction of photosynthetically active radiation absorbed by plant canopies (MOD15A2, 1km, 8-day). We will also use field-based presence/absence data from the two regions. We will then use a combination of logistic regression and classification systems, (e.g. CART and/or random forests) to develop models that predict locations with high invasion probabilities.

Melissa Hamar

Interpreting 250m Moderate Resolution Imaging Spectroradiometer Vegetation Indices in the Colorado Plateau, USA

Advisor: Dr. Michael A. White

The National Park Service (NPS) Vital Signs Monitoring program is an aggressive effort to track ecosystem status in the 270 park units. For large and remote parks, remote sensing may be used as an early warning system to detect anomalous vegetation conditions. Here, I evaluated the ability of the Moderate Resolution Imaging Spectroradiometer 250m Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and red, near infra-red, and blue channels to represent relative ground-measured vegetation conditions. Using an AccuPAR LP-80 PAR/LAI Ceptometer, LAI-2000 Plant Canopy Analyzer, and First Growth digital camera, I sampled plant area index (PAI) and green fractional cover (GFC) at 4 sites along a bioclimatic gradient representing semi-arid woodland, mixed grassland/shrubland, and grassland plant functional types. In 14 visits from June 2005 to October 2005, I intensively sampled each site at a spatial resolution directly comparable to 4 MODIS pixels. PAI was always less than 1.0 and often less than 0.4 and GFC was rarely greater than 5%. Likely due to such low plant cover and instrument noise, correlation coefficients between instruments were rarely significant. From both ground and MODIS data, the woodland site showed little evidence of phenological variability. For the other sites, all with a deciduous grassland component, the LP-80 was significantly and consistently related to NDVI (r2 0.57 to 0.79, slope 0.76 to 0.89) and less consistently to EVI. In spite of minimal base and amplitude of PAI and NDVI, it appears that MODIS NDVI is capable of resolving extremely subtle changes in herbaceous plant canopies and is therefore a promising tool for use in the Vital Signs Monitoring program.

Martin Buchert

Continuous Field Vegetation Classification of a Sagebrush (*Artemisia spp.*) Dominated Ecosystem Using High Spatial-Resolution, Multi-spectral Satellite Imagery

Advisor: Dr. Michael A. White

Current efforts to produce vegetation maps from remotely sensed data can capitalize on several recent developments: a growing recognition of the value of continuous, rather than categorical, map variables; civilian availability of very high resolution imagery; and a range of promising new classification techniques borrowed from the machine learning discipline.

The objectives of this study are to determine whether random forest classifiers outperform boosting and bagging classifiers in modeling vegetation percent cover from very fine grained satellite imagery, and to determine whether classification accuracy benefits from the inclusion of texture variables derived from the imagery as additional predictor variables.

Using Daubenmire plot estimates of land cover from a study site in northern Rich County, UT and 4m multispectral imagery from multiple dates across a vegetative growth season, I will train regression-trees to predict percent cover of woody and non-woody vegetation and bare ground and then classify the satellite imagery and ancillary data to produce maps of these three land covers. Reference data will be partitioned evenly into training and testing datasets prior to classification. I will assess classifier accuracy by the root mean square error (RMSE) in the modeled relationship between reference data and predictions, as well as examining the distribution of residuals in geographic space to identify potential patterns in classifier behavior.

This research will contribute to the ongoing dialogue articulating best practices in classifying high spatial resolution remotely sensed imagery, and will generate fine-grained maps of vegetative structure that will be useful in future habitat modeling for threatened sage-obligate species.