

# RESEARCH AND SYNTHESIS IN THE SAN JUAN MOUNTAINS, SOUTHWESTERN COLORADO

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## Introduction

The Mountain Studies Institute (MSI) is a non-profit research and education institution and high-altitude field station established in 2002 in Silverton, Colorado. MSI promotes, facilitates, and directly participates in research, monitoring, and synthesis efforts in the San Juan Mountains in order to understand how human activity alters natural ecosystems, and to provide information to land managers, government officials, educators, and the public.



The Historic Avon Hotel provides low-cost lodging, and meeting and classroom space

Silverton, Colorado, home to MSI



Sampling water in the Senator Beck Basin (Watershed was instrumented by the Center for Snow & Avalanche Studies)

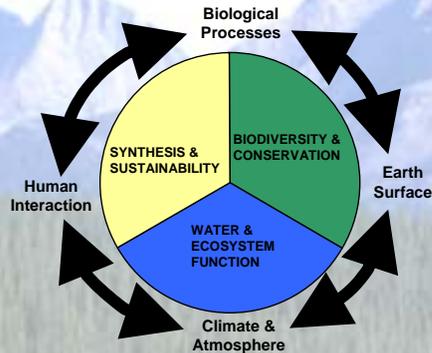
### Why the San Juan Mountains?

- Diverse geology, elevations, life zones, & ecosystems.
- Unique geography: mid-latitude mountains with bimodal precipitation regime.
- "Radiation" snow climate promotes dynamic snowpack.
- Major biogeographic boundaries
- Rare & sensitive species.
- Combination of vast wilderness areas & a millennial history of human involvement.
- Mountain towns in transition from historical mining-based economies to tourism & recreation.
- Ongoing community partnerships & stakeholder initiatives.



## Research Program

MSI facilitates monitoring, research, and synthesis activities in all the physical, biological, and social sciences and encourages interdisciplinary collaboration. The core of MSI's research program focuses on the areas shown below:



### WATER & ECOSYSTEM FUNCTION

Water plays a critical role in regulating ecosystem functions. Both abiotic and biotic factors, in turn, influence the quantity, timing, and quality of water delivered to mountain ecosystems and downstream users. The San Juans provide an excellent setting to explore the controls of geology and precipitation regime on hydrologic and ecosystem processes. MSI seeks to facilitate and directly participate in projects that investigate the natural variability and controls on hydrologic processes, the influence of hydrology on controlling ecosystem functions (such as nutrient and carbon cycling, biodiversity, disturbance, etc.), and the effects of global change on these processes and interactions.

### BIODIVERSITY & CONSERVATION

Mountains typically harbor less biodiversity than lowlands due to the constraints of harsh conditions. These harsh conditions, together with variable topography, however, promote rare and sensitive species, communities, and habitats. The San Juans host species found nowhere else in the world, such as certain arctic mosses that are relics of the last ice age. The diverse geology and bi-modal precipitation regime suggest that this mountain range may support more biodiversity than other similar elevations. How diverse is the biology of the San Juans and how will global change and resource use affect this biodiversity? MSI seeks to facilitate and participate in projects that synthesize data on biodiversity in the San Juans; perform inventories of under-studied groups of organisms; conduct monitoring, experiments, and modeling efforts investigating the controls on biodiversity and potential impacts of global change.

### SYNTHESIS & SUSTAINABILITY

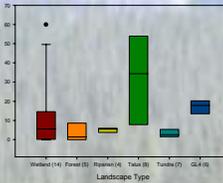
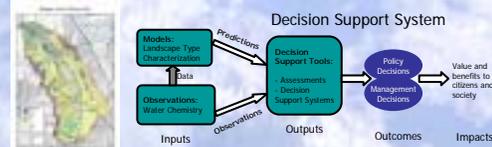
Research and monitoring activities are conducted by many entities in the San Juan Mountains and surrounding areas, but the efforts are often disjointed and results need to be synthesized and assessed based on resource use and global change scenarios. MSI seeks to facilitate and participate in projects that synthesize and assess existing information from a variety of sources. MSI also aims to integrate studies of physical and biological science with social, cultural, and economic investigations in order to promote sustainable use of the San Juan Mountains.

## Current Projects

### Decision Support System for Evaluating Alpine Sensitivity

Mark Williams and Kim Raby, funded by EPA

Goal: To use water quality data (existing and newly collected) and landscape type characterization to predict the sensitivity of alpine ecosystems to disturbance from human activity. This information will be transferred to policy makers and the public as user-friendly maps, datasets, and recommendations for ecosystem protection. (*Water & Ecosystem Function, Synthesis & Sustainability*)



Sensitive areas were identified: 1) areas underlain by disseminated pyrite were sensitive because of low acid neutralizing capacity and 2) Talus areas and some wetlands were sensitive due to high nitrate levels (shown to left).

Decisions about land use in the sensitive areas may include: 1) limited building footprint size, 2) minimized road construction, 3) restricted wintertime plowing, and 4) bans on septic system construction.

### Ecosystem functioning of fen wetlands

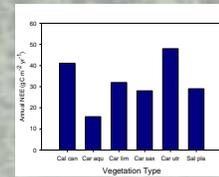
David Cooper and Rod Chimner, funded by the San Juan Fen Partnership



Goal: Fens support endemics and unique plant communities. To understand and manage fens, it is imperative to quantify processes that regulate carbon cycling and peat accumulation. Small disturbances or changes in vegetation may shift fens from net sinks to net sources of carbon. This project documented how different fen vegetation communities sequester and cycle carbon. (*Water & Ecosystem Function, Biodiversity & Conservation*)

Patterns and magnitudes of net ecosystem exchange of CO<sub>2</sub> (NEE — i.e., peat accumulation), gross photosynthesis (GPP), and ecosystem respiration (Re) were quantified in six different fen vegetation communities.

Summary: Because of variable environmental conditions, different vegetation communities cycled carbon at different rates. Surprisingly, however, all vegetation communities were accumulating carbon (i.e., peat) at similar rates.



Despite large differences in GPP and Re, all communities had similar NEE (shown above).

### Consolidation of San Juan Mountain Data Sources

- Searchable Database of Online Research Publications
- Collection of Scientific Databases
- GIS map layers See [www.mountainstudies.org](http://www.mountainstudies.org).



## Proposed Projects

### Fen Monitoring, Assessment, and Protection

(in collaboration with Colorado State University)



Goal: To conduct inventory and monitoring of fens throughout the San Juan Mountains, create a San Juan fen database and GIS map, and train managers and volunteers in fen assessment and use of the database and map.

Future proposals will include understanding the controls on fen hydrology and its influence on carbon cycling and community composition, and modeling responses to climate change. (*Water & Ecosystem Function, Biodiversity & Conservation, Synthesis & Sustainability*).

### Water Quantity and Quality in the San Juan Mountains: Controls of headwater processes

(in collaboration with Colorado School of Mines)

Goal: To characterize the flow paths and residence times of waters in headwater catchments. Given the varied geology of headwater basins in the San Juan mountains, we intend to address the question of geological controls on water sources and flow paths. The results of this work will be an initial step toward a more unified and transferable characterization of headwater geologic controls on stream water magnitude, timing, residence time, and quality. Future proposals will include modeling watershed hydrologic and ecosystem responses to climate change (*Water & Ecosystem Function*).

### Global Observation Research Initiative in Alpine Environments (GLORIA) Site in the San Juan Mountains

(in collaboration with the Center for Snow & Avalanche Studies)



The purpose of GLORIA is to establish a long-term observation network for comparative study of climate change impacts on mountain biodiversity, particularly vascular plants. A site in the San Juan Mountains would be extremely useful to understand alpine flora and impacts of climate change at a mid-latitude mountain range. The mid-latitude location promotes a higher radiation environment with a more developed summer monsoon compared to more northerly locations in the Rocky Mountains (*Biodiversity & Conservation*).

### Desert dust impacts on nutrient cycling in the San Juan Mountains of Colorado: Educational and Outreach Support

PI's Jason Neff & G. Farmer, University of Colorado

Goal: Provide educational and outreach support for this proposed project. (*Synthesis & Sustainability in support of Ecosystem Function research*)



Illustration of San Juan Mountain field sites in relation to the SW US deserts. The inset photo is a spring dust event on grazed lands in SE Utah during 2002.

### "State of the San Juans" Ecosystem Assessment

Goal: To hold a conference and support collaborative working groups aimed at collecting, assessing and synthesizing existing data sets. Certain sensitive ecosystems will be targeted for this activity. Data gaps will be identified. Indicators of ecosystem health will be developed and trends will be identified when enough data exists. When possible, future threats to ecosystems will be evaluated. Proposed products include a comprehensive report, GIS maps, and on-line resources. (*Synthesis and Sustainability*)