

Proceedings of the Third Interagency Conference on Research in the Watersheds

Planning for an Uncertain Future—Monitoring, Integration, and Adaptation



Scientific Investigations Report 2009–5049



Proceedings of the Third Interagency Conference on Research in the Watersheds

Planning for an Uncertain Future—Monitoring, Integration, and Adaptation

Edited by Richard M.T. Webb and Darius J. Semmens

Scientific Investigations Report 2009–5049

**U.S. Department of the Interior
U.S. Geological Survey**

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Preface

Richard M.T. Webb and Darius J. Semmens

These proceedings contain the presentations, discussions, and recommendations of the 91 participants of the Third Interagency Conference on Research in the Watersheds convened in Estes Park, CO, 8–11 September 2008.

Keywords: climate change, sustainable ecosystems, watershed management

If we learn, finally, that what we need to 'manage' is not the land so much as ourselves in the land, we will have turned the history of American land-use on its head.

—Senator Gaylord Nelson, Founder of Earth Day*

The 6.7 billion human inhabitants of the earth have the ability to drastically alter ecosystems and the populations of species that have taken eons to evolve. By better understanding how our actions affect the environment, we stand a better chance of designing successful strategies to manage ecosystems sustainably. Toward this end, the Third Interagency Conference on Research in the Watersheds (ICRW) was convened in Estes Park, CO, on September 8–11, 2008.

The Conference provided a forum to present adaptive management as a practical tool for learning how to manage complex ecosystems more sustainably. Further complexity introduced by spatially variable and continuously changing environmental drivers favors this management approach because of its emphasis on adaptation in response to changing conditions or ineffective actions. For climate change in particular, an adaptive approach can more effectively accommodate the uncertainty in future climate scenarios.

Scenarios compiled by the Intergovernmental Panel on Climate Change are built on distinct economic, energy, and societal models. The scenarios predict potential changes in greenhouse gases, temperature, precipitation, and atmospheric aerosols, which would

have direct or indirect impacts on the timing, volume, and quality of runoff, vegetation, snowpack, stream temperature, groundwater, thawing permafrost, and icecaps.

Through presentations and field trips, researchers and stakeholders described how their findings and issues fit into the adaptive management ‘learning by doing’ paradigm of Assess > Design > Implement > Monitor > Evaluate > Adjust > Assess.

Watersheds are the primary planning unit being used for resource management and the natural unit for research studies on surface water hydrology and water quality. A goal for all ICRW conferences is to bring together researchers working at the watershed scale and stakeholders living and working in the watersheds. The Third ICRW was hosted by the U.S. Geological Survey (USGS) and the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI), with contributions from the Environmental Protection Agency, the Department of Agriculture (Agricultural Research Service; Natural Resource and Conservation Service; U.S. Forest Service), the Department of Interior (National Park Service; Bureau of Reclamation; U.S. Fish and Wildlife Service), and the National Oceanic and Atmospheric Administration. The conference was convened in Estes Park with 91 scientists, water managers, policy makers, and local stakeholders.

In recognition of the difficulties associated with maintaining focus for such a diverse group of participants on such a broad range of topics, two preconference workshops were held on Sunday and Monday, September 7–8. The first workshop focused on Collaborative Competencies, facilitated by Todd Bryan, Senior Associate with the Keystone Center, Glendale Springs, CO, and the second on Adaptive Management, facilitated by Ken Williams, Chief of Cooperative Programs, USGS, Reston, VA.

Eric Kuhn, General Manager of the Colorado River Conservation District, provided the keynote welcome speech on Monday evening. He explained the uncertainties and unresolved legal disputes involved

* Nelson, G. 1994. Foreward. In D. Zaslow, T.H. Watkins, and The Wilderness Society, *These American Lands: Parks, Wilderness, and the Public Lands*, p. xv. Island Press, Washington DC.

with “the law of the river,” the complex and often conflicting compacts, treaties, and Federal and State statutes that apply to those who share the Colorado River’s wealth among the states of Arizona, California, Colorado, New Mexico, and Utah and the Republic of Mexico. Kuhn said, “New tools will be needed as we transition from the era of development to a new era of uncertainties.” He said that within the Colorado River Basin there are three major sources of uncertainty: hydrology, demands, and unresolved legal disputes. Climate change brings in even more uncertainty, suggesting a future with less streamflow. Current climate science suggests that the southwestern United States and lower elevation watersheds will be most susceptible to impacts of climate change. To help manage these uncertainties, he suggested three broad strategies: (1) early identification of unacceptable outcomes; (2) maintenance of positive relationships among stakeholders; and (3) better integration of science into decisionmaking.

A series of overview talks opened the Tuesday plenary sessions. Following the plenary sessions, participants split into four regional tracks: Arid West, Interior Temperate and Boreal, Low Latitudes and Maritime, and National. For each track, descriptions of research progressed through climate, geology, geomorphology, hydrology, biogeochemistry, ecology, human impacts, and management. Equal time was allotted to presentations and subsequent facilitated discussions of the research presented in terms of its position within the adaptive management framework.

Field trips on Wednesday highlighted collaborative ecological research in Rocky Mountain National Park and Niwot Ridge, a long-term ecological research station.

On Wednesday night two top researchers were recognized. Tom Winter of the U.S. Geological Survey was presented an ‘Insight Award’ for his outstanding contributions to science-driven watershed management. Susan Moran of the Agricultural Research Service was recognized with a ‘Founder’s Award’ in recognition of her outstanding vision and leadership in establishing the Interagency Conference on Research in the Watersheds.

The conference concluded on Thursday morning with a plenary session describing specific applications of adaptive management at the watershed scale followed

by an open discussion of lessons and suggestions, some of which included:

- The adaptive management paradigm is the familiar scientific method with management used as a treatment.
- Most global climate models predict increasing temperatures for the next century, resulting in greater potential evapotranspiration and greater water-holding capacity of the atmosphere. Water managers should therefore plan for drier soils and greater variability in the weather, i.e. bigger floods and extended droughts.
- Adaptive management is well suited for watersheds with difficult issues, competing interests, and uncertain models of how the system will respond to a given management approach. Stakeholder buy-in is critical for success, as are necessary institutional changes.
- Scientists and managers have different backgrounds and purposes. Asking scientists to place their research in the context of management is like trying to force a square peg into a round hole. Similarly, managers are unclear as to the role of open-ended, curiosity driven research in the short-term management of watersheds. Co-location of scientists and resource managers, as practiced by some management agencies, would enhance science-driven management in complex watersheds. In the long run, existing bureaucracies and management approaches will need to be overhauled if adaptive management is to become a standard approach in watershed management .
- The time needed to travel through one revolution of the adaptive management paradigm—Assess > Design > Implement > Monitor > Evaluate > Adjust > Assess—is much less for issues confronting local and regional watersheds with a limited number of goals and stakeholders than it is for national or global environmental issues where policies, science, and the needs of stakeholders are more complex.
- Two immediate needs were identified: (1) the use of social scientists, similar to agricultural extension agents, as liaisons between the managers and stakeholders in the watershed and the scientists and policy makers who can

be out of touch with local issues and conditions; and (2) more accurate downscaling of coarse global climate models to finer resolutions needed by municipal and regional managers of watersheds and ecosystems.

The Fourth ICRW will be hosted by the Bureau of Land Management in Fairbanks, AK, home to multiple agencies looking at how to best manage ecosystems actively responding to current warming trends. Updates will be made available on the conference website <http://www.hydrologicscience.org/icrw/>.

Acknowledgments

The following individuals, listed in alphabetical order, contributed their time and effort to making the conference a success:

Steering Committee

Jill Baron, U.S. Geological Survey
Ben Blaney, Environmental Protection Agency
Levi Brekke, Bureau of Reclamation
Don Campbell, U.S. Geological Survey
Dave Clow, U.S. Geological Survey
Dick "Randy" Fowler, U.S. Forest Service
Earl Greene, U.S. Geological Survey
Deborah Hayes, U.S. Forest Service
Rick Hooper, Consortium of Universities for the
Advancement of Hydrologic Science, Inc.
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Jason Krutz, Agricultural Research Service
Susan Moran, Agricultural Research Service
Pete Murdoch, U.S. Geological Survey
Jim Nichols, Environmental Protection Agency
Glenn G. Patterson, National Park Service / U.S.
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Darius Semmens, U.S. Geological Survey
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Richard Webb, U.S. Geological Survey
Ken Williams, U.S. Geological Survey
Mark Williams, University of Colorado

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Heather Golden, Environmental Protection Agency
Rick Hooper, Consortium of Universities for the
Advancement of Hydrologic Science, Inc.
Deborah Martin, U.S. Geological Survey
Cassandra Mullinix, U.S. Geological Survey
Pete Murdoch, U.S. Geological Survey
Jake Peters, U.S. Geological Survey
Darius Semmens, U.S. Geological Survey
Jamie Shanley, U.S. Geological Survey
Michelle Walvoord, U.S. Geological Survey
Richard Webb, U.S. Geological Survey
Ed Weeks, U.S. Geological Survey

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Deborah Martin, U.S. Geological Survey
Alisa Mast, U.S. Geological Survey
Glenn G. Patterson, National Park Service
Travis Schmidt, U.S. Geological Survey
Judy Visty, National Park Service
Mark Williams, University of Colorado

Facilitation

Todd Bryan, Keystone Center
Jody Erickson, Keystone Center

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Conversion Factors

[To convert from inch/pound to SI units divide by the conversion factor]

Multiply	By	To obtain
Length		
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
Area		
square kilometer (km ²)	247.1	acre
hectare (ha)	2.471	acre
square meter (m ²)	10.76	square foot (ft ²)
square kilometer (km ²)	0.3861	square mile (mi ²)
Volume		
liter (L)	0.2642	gallon (gal)
cubic meter (m ³)	264.2	gallon (gal)
cubic meter (m ³)	35.31	cubic foot (ft ³)
cubic meter (m ³)	0.000811	acre-ft (acre-ft)
cubic meter (m ³)	6.289811	barrel, petroleum
Rate		
cubic meter per second (m ³ /s)	70.07	acre-foot per day (acre-ft/d)
cubic meter per second (m ³ /s)	35.31	cubic foot per second (ft ³ /s or cfs)
cubic meter per day (m ³ /d)	35.31	cubic foot per day (ft ³ /d)
cubic meter per day (m ³ /d)	264.2	gallon per day (gal/d)
meter per second (m/s)	3.281	foot per second (ft/s)
meter per day (m/d)	3.281	foot per day (ft/d)
cubic meter per kilometer (m ³ /km)	56.83	cubic foot per mile (ft ³ /mi)
kilogram per second (kg/s)	2.205	pound per second (lb/s)
Mass		
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)
Pressure		
kilopascal (kPa)	0.2961	inch of mercury at 60°F (in Hg)
kilopascal (kPa)	0.1450	pound per square inch (lb/ft ²)
Density		
gram per cubic centimeter (g/cm ³)	62.4220	pound per cubic foot (lb/ft ³)

Hydraulic conductivity		
meter per day (m/d)	3.281	foot per day (ft/d)
Loading or yield		
kilogram per hectare (kg/ha)	0.89218	pound per acre(lb/acre)
Power		
Watt per square meter (W/m ²)	2.069	Langley per day
kilowatt-hour (kW-h)	3,410	British Thermal Unit (BTU)
Transmissivity		
meter squared per day (m ² /d)	10.76	foot squared per day (ft ² /d)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) / 1.8$$

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviations Used in This Report

gram	g
liter	L
meter	m
milliequivalent	meq
millimole	mmol
micromole	μmol
mole	mol
molar	M
percent	%
per mille	‰
parts per million	ppm
parts per billion	ppb

Acronyms are defined the first time they are used in each manuscript.

Planning for an Uncertain Future— Monitoring, Integration, and Adaptation

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Richard M.T. Webb and Darius J. Semmens, editors

Conference Program

Preconference Workshops

Sunday, September 7, 2:00PM–8:00PM

Collaborative Competencies, facilitated by Todd Bryan, Principal with the Keystone Center, Glendale Springs, CO

Monday, September 8, 8:00AM–2:00PM

Adaptive Management, facilitated by Ken Williams, Chief of Cooperative Programs, USGS, Reston, VA

Monday, September 8

5:00 PM Arrival / Check in / Registration

6:00 PM Welcome Speech—Eric Kuhn, General Manager of the Colorado River Conservation District

6:20 PM Barbecue at Trails End

Tuesday, September 9

7:00 AM Breakfast / Registration

8:00 AM Welcome and Orientation

8:20 AM Adaptive Management of Renewable Natural Resources—Ken Williams, Chief of Cooperative Programs, USGS Biological Resources Discipline

8:40 AM Strengthening Connections Between Science and Management: Some Recent Developments in the National Park Service—Jeff Albright, Hydrologist, Natural Resources Program, National Park Service

9:00 AM Kelly Elder, Research Hydrologist, National Forest Service

9:20 AM The National Wildlife Refuge System and Resource Management in a Watershed Context—Andy Loranger, Chief, Division of Natural Resources and Conservation Planning, National Wildlife Refuge System, U.S. Fish and Wildlife Service

9:40 AM Break

10:00 AM American Indian Tribes and the Development of Water Resources—Daniel Cordalis, Former natural resources legislative assistant with the National Congress of American Indians

10:20 AM Water Cycle Changes as the Primary Delivery Mechanism for Climate Change Impacts—Brad Udall, Director, CU-NOAA Western Water Assessment

10:40 AM ARS' Benchmark Watershed Research Network: Past Accomplishments, Present Status, and Future Directions—M.R. Walbridge, National Program Leader, Agricultural Research Service

11:00 AM Watershed Management Research in the US EPA—Chuck Noss, National Program Director, Water Quality Research

11:20 AM Curt Brown, Director, Office of Research and Development, Bureau of Reclamation

11:40 AM Watershed Research: Needs and Opportunities—Ron Huntsinger, National Science Coordinator, Bureau of Land Management

12:00 PM Lunch

1:00 PM Pierre Glynn, Chief of National Research Program, Eastern Region

- 1:20 PM Contributions of the University Community to Watershed Research—R.P. Hooper, D.R. Maidment, and D.B. Kirschtel, Director, Consortium of Universities for the Advancement of Hydrologic Science
- 1:40 PM Gregg Garfin, Director of Science Translation and Outreach, Institute for the Study of Planet Earth, University of Arizona
- 2:00 PM Ground Rules for Regional Forums on Adaptive Management
- 2:20 PM Break

2:40 PM	National (Nat) (Meeker)	Arid West (AW) (Longs Peak)	Interior Temperate and Boreal (ITB) (Lady Wash)	Low Latitudes and Maritime (LLM) (Twin Sisters)
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Panel discussions will identify goals, objectives, stakeholders, current science, uncertainty, and monitoring needs for candidate watersheds. Separate tracks for National (NAT), Arid West (AW), Interior Temperate and Boreal (ITB), and Low Latitudes and Maritime (LLM).

Regional Session 1: Climate, Geology, and Geomorphology

	NAT1 Moderator: Pete Murdoch	AW1 Moderator: Stan Church	ITB1 Moderator: Michelle Walvoord	LLM1 Moderator: Jamie Shanley
3:30 PM	Considerations in Defining Climate Change Scenarios for Water Resources Planning—L.D. Brekke	Long-Term Snow, Climate, and Streamflow Trends at the Reynolds Creek Experimental Watershed, Owyhee Mountains, Idaho, USA—D. Marks, A. Nayak, M. Seyfried, and D. Chandler	Impacts on Water and Ecological Resources in the Yukon River Basin Due to Historical Changes in Climate—Michelle Walvoord and Paul Schuster	Evaluating Hydrological Response to Forecasted Land-Use Change: Scenario Testing with the Automated Geospatial Watershed Assessment Tool—William G. Kepner, Darius J. Semmens, Mariano Hernandez, and David C. Goodrich
3:50 PM	Impacts of Coalbed Methane Development on Water Quantity and Quality in the Powder River Basin—G.B. Paige and L.C. Munn	Environmental Effects of Hydrothermal Alteration on Water and Sediment Quality in Central Colorado—S.E. Church, D.L. Fey, T.S. Schmidt, R.B. Wanty, B.W. Rockwell, C.A. San Juan, P.L. Verplanck, and M. Adams	U.S. Geological Survey Research in Handcart Gulch, Colorado: An Alpine Watershed with Natural Acid-Rock Drainage—A.H. Manning, J.S. Caine, P.L. Verplanck, and D.J. Bove	Water Quality Impacts from Agricultural Land-Use in Karst Drainage Basins of SW Kentucky and SW China—T.W. Baker and C.G. Groves
4:10 PM	Impacts of Forest Management on Runoff and Erosion—W.J. Elliot and B.D. Glaza	Paleoflood Research of South Boulder Creek Basin near Boulder, Colorado—Robert D. Jarrett and Justin C. Ferris	Modeled Watershed Runoff Associated with Variations in Precipitation Data, with Implications for Contaminant Fluxes—Heather E. Golden, Christopher D. Knightes, Ellen J. Cooter, and Robin L. Dennis	Post-Fire Watershed Response at the Wildland/Urban Interface, Southern California—Peter M. Wholgemuth

4:30 PM Break

Regional Session 2: Hydrology, Biogeochemistry, and Ecology

	NAT2 Moderator: Rick Webb	AW2 Moderator: Ed Weeks	ITB2 Moderator: Darius Semmens	LLM2 Moderator: Jake Peters
4:40 PM	The USGS Hydrologic Benchmark Network: Capabilities and Opportunities for Collaborative Monitoring and Research—D.W. Clow, M.A. Mast, M. McHale, and M. Nilles	Using Diurnal Surface Temperature Variation to Monitor Evaporation from Soils in a Semiarid Rangeland—M. Susan Moran, Russell L. Scott, Timothy O. Keefer, William E. Emmerich, and Erik P. Hamerlynck	Using a Coupled Ground-Water/Surface-Water Model to Predict Climate-Change Impacts to Lakes in the Trout Lake Watershed, Northern Wisconsin—John F. Walker, Randall J. Hunt, Steven L. Markstrom, Lauren E. Hay, and John Doherty	Isotopic Signatures of Precipitation Quantify the Importance of Different Climate Patterns to the Hydrologic Budget: An Example from the Luquillo Mountains, Puerto Rico—M.A. Scholl and J.P. Shanley
5:00 PM	Mercury Cycling Research Using the Small Watershed—Jamie Shanley and Ann Chalmers	Using Passive Capillary Samplers to Collect Snowmelt Recharge and Soil-Meltwater Endmembers for Stable Isotope Analysis—Marty D. Frisbee, Fred M. Phillips, Andrew R. Campbell, and Jan M.H. Hendrickx	The Role for High Frequency Sampling in Documenting the Effects of Atmospheric Pollutants on Stream Chemistry—Stephen D. Sebestyen, Jamie Shanley, and Elizabeth Boyer	Effects of 21 Years of Climate Variation and Regional Urbanization on Precipitation and Streamwater Chemistry of a Relatively Undisturbed Forested Watershed near Atlanta, Georgia—Norman E. Peters and Brent T. Aulenbach
5:20 PM	Responses of Benthic Macroinvertebrates to Environmental Changes Associated with Urbanization in Nine Metropolitan Areas of the Conterminous United States—T.F. Cuffney, G. McMahon, J.T. May, and I.A. Waite	The Effect of Mining on Aquatic Communities in Central Colorado—T.S. Schmidt, S.E. Church, W.H. Clements, K. Mitchell, D.L. Fey, R.B. Wanty, P.L. Verplanck, C.A. San Juan, and M. Adams	Timber Harvest, Turbidity, and Implications for Anadromous Salmonids in North Coastal California Streams—R.D. Klein	Facilitating Adaptive Management in the Chesapeake Bay Watershed through the Use of On-Line Decision Support Tools—C. Mullinix, S. Phillips, and P. Hearn

6:00 PM Dinner in the Ptarmigan Dining Room

6:30 PM

Poster Session in the Lodge

Forecasting Colorado Streamflow under Natural Climate Variability—Jason Gurdak	Monitoring Hydrological Changes Related to Western Juniper Removal: A Paired Watershed Approach—Tim Deboodt, Mike Fisher, John Buckhouse, and John Swanson	Basin Attributes Contributing to Chemical Composition of Streamwater in Headwater Catchments of the Colorado Rockies—C. Rhoades, J. Norman III, E. Kelly, and K. Elder	A Study on Seed Dispersal by Hydrochory in Floodplain Restoration—H. Hayashi, Y. Shimatani, and Y. Kawaguchi
Lessons Learned in Calibrating and Monitoring a Paired Watershed Study in Oregon's High Desert—Mike Fisher, Tim Deboodt, John Buckhouse, and John Swanson	Hydrologic Instrumentation and Data Collection in Wyoming—G.B. Paige, S.N. Miller, T.J. Kelleners, and S.T. Gray	High Spatial and Temporal Rainfall Analyses for Use in Watershed Models—Douglas Hultstrand, Tye Parzybok, Ed Tomlinson, and Bill Kappel	Watershed Management in Nepal—Tak Bahadur Tamang
Reflections on the July 31, 1976, Big Thompson Flood, Colorado Front Range, USA—Robert D. Jarret and John E. Costa	A Synergistic Approach to Hydrologic Research and Education in the Yukon River Basin—Paul Schuster and Michelle Walvoord	Effects of Mountain Pine Beetle Induced Tree Mortality on Carbon and Nitrogen Fluxes in Northern Colorado—Dave Clow and others	Climate-Induced Changes in High Elevation Nitrogen Dynamics—Jill S. Baron, Travis M. Schmidt, and Melannie D. Hartman
Potential Climate Impacts on the Hydrology of High Elevation Catchments, Colorado Front Range—M.W. Williams, K.H. Hill, N. Caine, J.R. Janke, and T. Kittel			

Wednesday, September 10

(Breakfast available at 6:30 AM)

Field Trips (Box Lunch)

7:00 AM Andrew's Meadow*—Alisa Mast

Icy Brook*—Dave Clow

7:45 AM Loch Vale*—Don Campbell

Long Term Ecological Research on Niwot Ridge—Mark Williams

8:30 AM Aquatic Ecology of the Big Thompson River and Cub Lake—Glenn Patterson and Travis Schmidt

Floods, Paleofloods, and Wildfire Hydrology, Big Thompson Canyon—Deborah Martin and Bob Jarrett

4:00 PM Return to Lodge

*All Loch Vale trips start at the Glacier Gorge trailhead, which is at 9,180 ft elevation. The Loch: 7 miles (RT), 1,000 ft elevation gain, all on trail. Andrew's Meadow: 8.5 miles (RT), 1,320 ft elevation gain, all on trail. Icy Brook/Glass Lake: 10 miles (RT), 1,670 ft elevation gain, mostly on trail, some class 2 scrambling (requires use of hands) above treeline.

Bring: Layered clothing as appropriate, jacket, rain coat or poncho, box lunch, back pack, water bottle, sunscreen, lip balm, good sneakers or hiking shoes or boots, camera.

Regional Session 3: Human Impacts and Management

	NAT3 Moderator: Brian Caruso	AW3 Moderator: Deb Martin (Fireside)	ITB3 Moderator: Heather Golden	LLM3 Moderator: Rick Webb
4:40 PM	The Importance of Considering Aquifer Susceptibility and Uncertainty in Developing Water Management and Policy Guidelines—Tristan Wellman	Evaluating Regional Patterns in Nitrate Sources to Watersheds in National Parks of the Rocky Mountains Using Nitrate Isotopes—Leora Nanus, Mark W. Williams, Donald H. Campbell, Carol Kendall, and Emily M. Elliot	USDA–ARS and Filtrexx International Research on Storm Water Pollutant Removal Effectiveness of Compost Filter Socks—Britt Faucette	Long-Term Patterns of Hydrologic Response after Logging in a Coastal Redwood Forest—Elizabeth Keppeler, Leslie Reid, and Tom Lisle
5:00 PM	Water Quality Screening Tools: A Practical Approach—Benjamin Houston and Rob Klosowski	Design and Implementation of a Water-Quality Monitoring Program in Support of Establishing User Capacities in Yosemite National Park—R.S. Peavler, D.W. Clow, A.K. Panorska, and J.M. Thomas	Herbicide Transport Trends in Goodwater Creek Experimental Watershed—R.N. Lerch, E.J. Sadler, K.A. Sudduth, and C. Baffaut	Assessing Changes in Hydrologic Function Using Historical Records and Contemporary Measurements—C.C. Trettin, D.A. Amatya, C. Kaufman, R. Morgan, and N. Levine
5:20 PM	Break	A Watershed Condition Assessment of Rocky Mountain National Park Using the FLoWS Tools—David M. Theobald and John B. Norman	Integrating Terrestrial LiDAR and Real Time Kinematic GPS Surveys to Map the Upper Tolay Creek Watershed of San Francisco Bay—Isa Woo, John Takekawa, Rachel Gardiner, and Rune Storesound	Does Climate Matter? Evaluating the Effects of Climate Change on Future Ethiopian Hydropower— Paul Block
6:00 PM	Awards Banquet in Longs Peak			

Thursday, September 11

7:00 AM Breakfast, checkout and luggage prep

Plenary Session: Observing and Adapting **Moderator: Rick Hooper**

8:00 AM An Ecosystems Services Framework for Multi-Disciplinary Research in the Colorado River Headwaters—D.J. Semmens, J.S. Briggs, and D.A. Martin

8:20 AM The Finger Lakes Watershed Environmental Network (FLoWEN): A Web Services Based Approach to Environmental Monitoring Data Management—Fred Pieper, Ricardo Lopez-Torrijos, and Benjamin Houston

8:40 AM Everglades Restoration: Balancing Ecosystem Recovery and Expanding Development at the Watershed Level—R.A. Johnson

9:00 AM Break

9:20 AM National Collaborative Observation and Research (CORE) Watersheds: A Strategy for Tracking the Effects of Climate Change on Complex Systems—P.S. Murdoch, D.L. Cecil, J.W. Harden, P.H. Dunn, and R.A. Birdsey

9:40 AM Engaging Stakeholders for Adaptive Management Using Structured Decision Analysis—Elise R. Irwin and Kathryn D.M. Kennedy

10:00 AM Break

10:20 AM	NAT Panel Plans	AW Panel Plans	ITB Panel Plans
	LLM Panel Plans		

11:00 AM Present Plans

12:00 PM Lunch and adjourn

1:00 PM Shuttle leaves for airport

