Colorado Water

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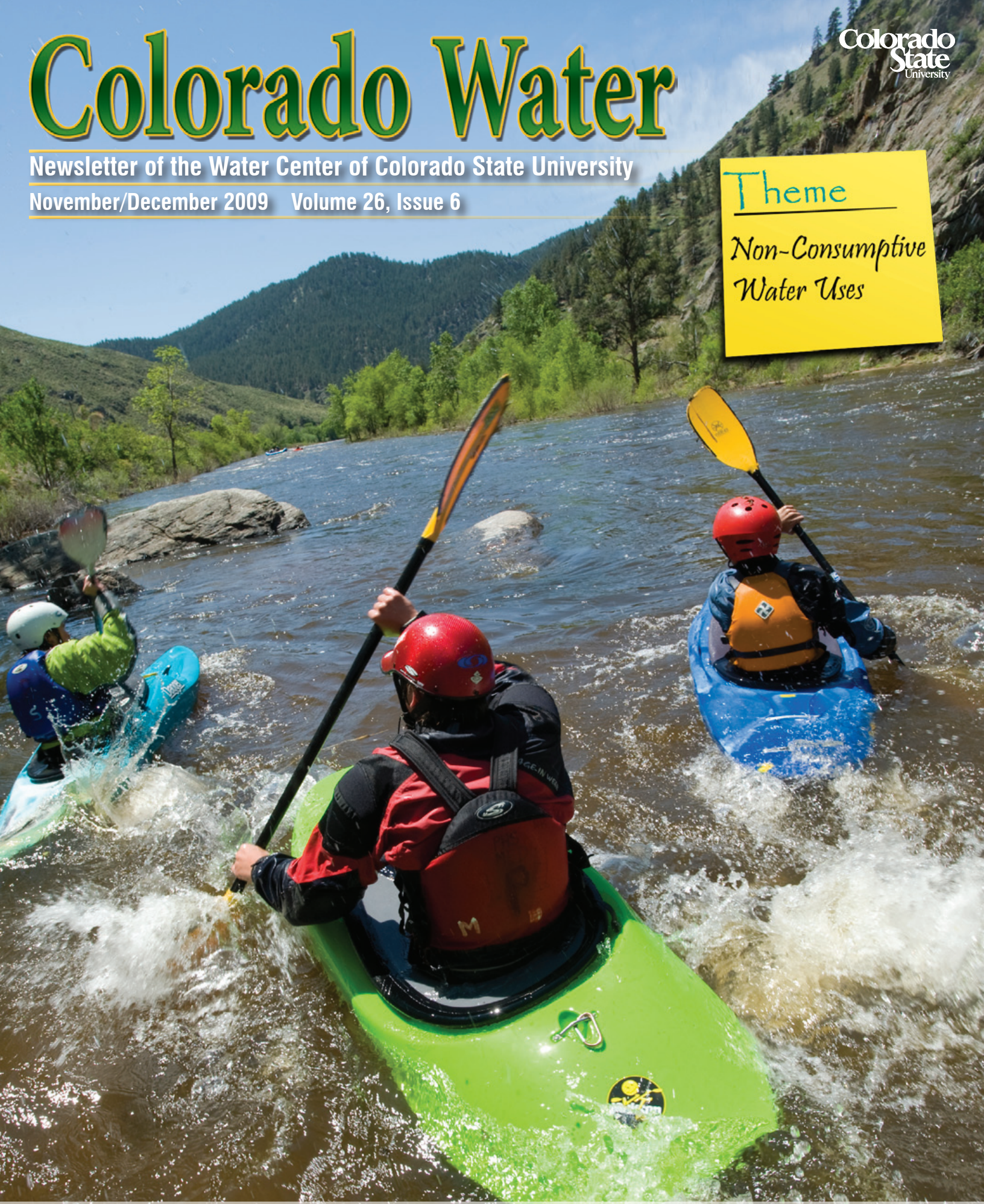
Theme

Non-Consumptive Water Uses



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Highlights

In Every Issue

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Front Cover: Kayakers paddle on the Cache la Poudre River in northern Colorado. (Photo by William A. Cotton/CSU Photography)

Editorial

by Reagan Waskom, Director, Colorado Water Institute

Current Colorado water law embodies the summation of almost 150 years of legal, constitutional, and administrative wrangling, reflecting the overall customs and values of our state. While most of this body of law guides traditional consumptive uses of water, Colorado law has evolved significantly during the last decade to include new uses of water in response to our society's changing values.

Remarkably, during the early part of this decade in the midst of one of the most severe droughts of modern time, our courts and state legislature provided statutory clarification allowing the appropriation of new in-channel water rights for kayak courses. These discussions and changes were occurring while many water rights holders were unable to divert any water under the priority system due to the drought. Further evidence of the changing nature of Colorado law is evidenced in House Bill 05-1177, which authorizes the nine Basin Roundtables and requires them to quantify both consumptive and non-consumptive water needs in their respective basins. This concept of quantifying non-consumptive water needs was revolutionary, as it brought the entire water community—not just the recreational and environmental communities—into the discussion about how much water should be left in the natural stream as we develop the resource under our compact entitlements.

Even more recent legislation under House Bill 08-1280 provides Colorado water right holders with added protection against claims of abandonment if they lease or donate water rights to the Colorado Water Conservation Board for instream flow purposes. Claims that Colorado water law is moribund and serves only to protect traditional water rights holders are hard to support given these recent changes.

The concept of beneficial use in Colorado has long been construed to require the diversion of water from the natural stream to where it can be used for consumption by humans to produce food, energy, and the various products and amenities of modern civilization. In contrast, water use is considered non-consumptive when there is no diminishment of the source by human use. Boating and fishing are the most obvious non-consumptive uses, but flows for the benefit of the natural environment and aquatic habitat are arguably even more important, as they help maintain the benefits and services provided by a healthy ecosystem.

This water may be used by humans (e.g., municipalities or industry), by recreational enthusiasts (e.g., fishing or boating), or by the environment. As an added benefit, the non-consumptive use of water allows multiple uses by others downstream. The fundamental change under the Supreme Court rulings on recreational in-channel diversion cases in Fort Collins, Golden, and Gunnison was that it established that water for recreation that was left in the stream had the same standing under doctrine of prior appropriation as any other water right.

The challenge in all of this lies in actually determining the amount of flow necessary and reasonable for a given non-consumptive beneficial use or determining how much water is needed to preserve a given aquatic ecosystem. This issue of *Colorado Water* highlights some recent efforts to quantify these non-consumptive needs. Several faculty members at CSU and their agency counterparts are working to develop flow determination models and tools for assessing ecological condition. These efforts are summarized in articles by John Sanderson of The Nature Conservancy and Professors David Theobold and Brett Johnson of CSU and their agency partners at the CWCB. The recreational side of water use is a significant economic driver in Colorado, yet some controversy remains on the public's right to float across private lands in Colorado, as highlighted in the written debate provided by Attorneys John Hill and Lori Potter. Clearly, Colorado water law continues to evolve as we sort out, in fits and starts, the changing values and preferences of our state's citizens.

Quantifying Non-Consumptive Needs in Colorado: the Watershed Flow Evaluation Tool

by John Sanderson, Senior Freshwater Ecologist, The Nature Conservancy of Colorado

Water demand by municipalities and industry in Colorado could more than double by 2050 if our state population grows as predicted—from 5 million to 10 million residents. In recognition of growing water concerns, Colorado's General Assembly passed the Water for the 21st Century Act (HB05-1177), establishing the Interbasin Compact Committee and Basin Roundtables to "develop [a] basin-wide consumptive and non-consumptive water supply needs assessment . . . and propose projects or methods . . . for meeting those needs." The non-consumptive needs assessment consists of two tracks: (1) identifying stream and river segments with important environmental and recreational attributes, and (2) identifying projects and methods to meet the non-consumptive needs, including determining the quantity and timing of water necessary to maintain stream and river attributes.

Streamflows needed to maintain healthy river ecosystems have been quantified in detail for many locations. Unfortunately, the high cost of detailed studies will always constrain their application to a very limited number of stream miles. To deal with the combined problem of limited resources and great need, we developed two pilot applications of the Watershed Flow Evaluation Tool (WFET), an approach to watershed-scale, science-based assessment of flow-related ecological risk throughout a basin where site-specific studies are sparse.

Development of the Watershed Flow Evaluation Tool

The WFET is a Colorado-specific application of a new framework for assessing environmental flow needs at a regional scale called the Ecological Limits of Hydrologic Alteration (ELOHA). The ELOHA framework is a consensus view from a group of international scientists on a flexible, scientifically defensible approach to flow assessment where sufficient numbers of in-depth studies are not available. Our WFET pilots were done in the Roaring Fork and Fountain Creek Watersheds.

The Fountain Creek pilot WFET application demonstrated the limits of this tool. In the Fountain Creek Watershed, hydrologic data were limited and the primary ecological concerns there were related to flow augmentation, not depletion. Few studies of the effects of flow augmentation exist. Because of these limitations, we focus the rest of this article on the Roaring Fork pilot study.

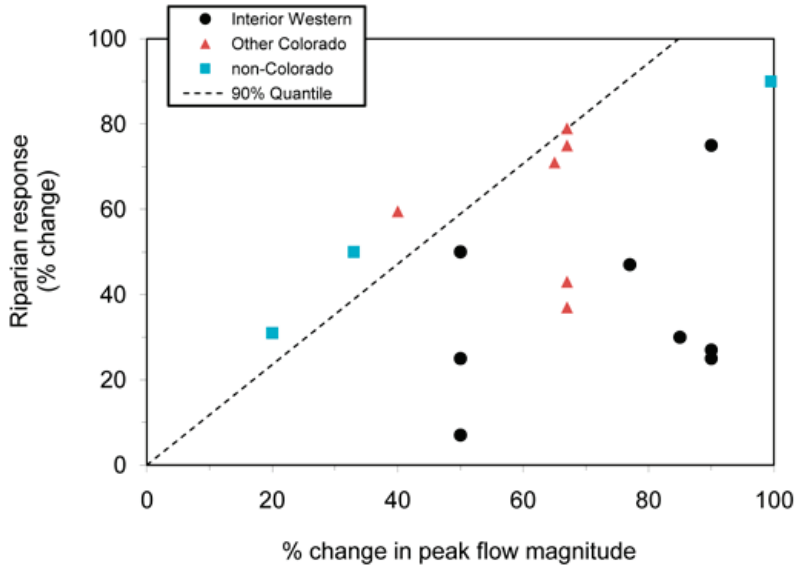
The WFET was developed in four steps: (1) modeling natural and existing daily streamflows, (2) analyzing the resulting flow time series, (3) describing relationships between important river attributes and key flow metrics (called 'flow–ecology relationships'), and (4) mapping flow-

A segment of the Roaring Fork River east of Aspen experiences minimal flow risks to trout, but moderate risk to the riparian ecosystem. Inset: a portion of the Independence Pass Transmountain Diversion System diverts an average 38,000 acre feet of water from the Roaring Fork Watershed to the Front Range.

related risk for trout, native at-risk warm-water species, and riparian plant communities.

We used the State of Colorado's Stream Simulation Model (StateMod) to model daily flow values for 1975-2005 at 47 locations in the Roaring Fork basin. Changes, if any, between natural and existing conditions were then calculated using the Indicators of Hydrologic Alteration software developed by The Nature Conservancy. From this analysis we focused on five flow metrics (e.g., mean annual peak daily flow, August and September mean monthly flow) that were relevant to one or more stream attributes. The ecosystem response to flow alteration was described through a review of 149 published studies, with additional input from some of the state's top fish biologists. With an understanding of how much flow has changed in the Roaring Fork and the likely ecological response to flow change, we were then able to map flow-related risk levels for ecological attributes across the basin (from low to high). Our results compared favorably with site-specific studies of trout and riparian vegetation, confirming two expectations: site-specific analyses and the WFET are complementary, and site-specific studies could be used to calibrate risk categories.

(a)



(b)

Rating	Summer low flow (% of mean annual flow)	Description
0 (worst)	<10%	Inadequate to support trout.
1	10-15%	Potential for trout support is sporadic.
2	16-25%	May severely limit trout stock every few years.
3	26-55%	Low flow may occasionally limit trout numbers.
4 (best)	>55%	Low flow may very seldom limit trout.

These figures represent examples of (a) continuous and (b) categorical relationships between flow alteration and ecological response. In (a), the dashed line indicates the degree of change in riparian plant communities that might occur with a change in peak flow. In (b), the categories indicate the expected suitability of trout habitat for a given amount of late-summer flow. These relationships do not account for other factors (e.g., land use and water quality) that may also affect the stream.

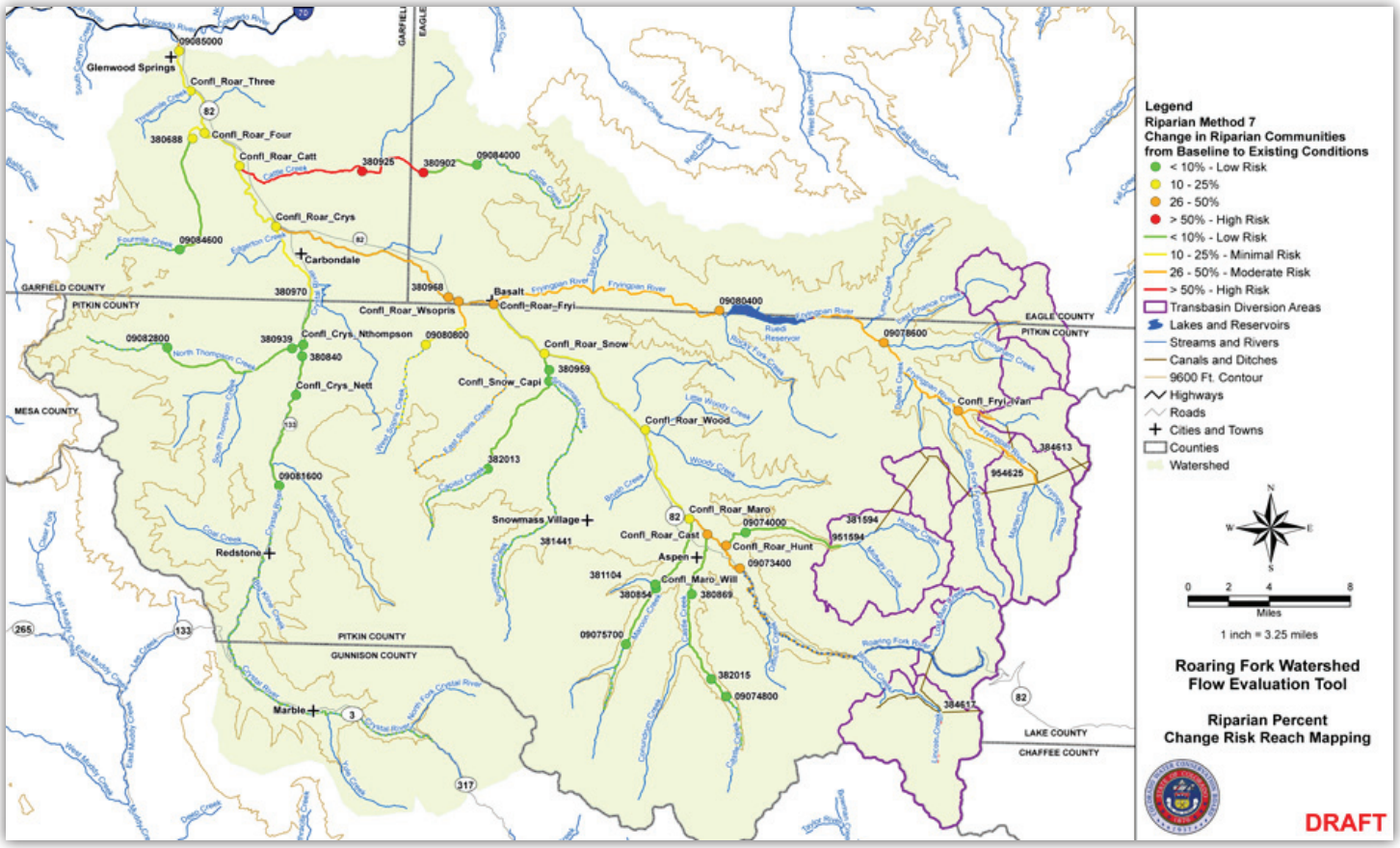
Trout Habitat is Doing Fine; Some Riparian Areas are at Risk

Flow alteration in the Roaring Fork Watershed ranged from none in some streams to more than 50% in others; consequently, risk to stream attributes ranged from minimal to severe. Trout habitat suitability was at low risk throughout the basin except at a couple of streams where conditions were naturally marginal. One reach (below Ruedi Reservoir) showed improved habitat for trout with increased baseflows compared to natural conditions. We also found low risk where imperiled native fish are found. In contrast, riparian habitats were at moderate to high risk of impact for a quarter of the nodes in the basin. These moderate- to high-risk nodes are below major transbasin and in-basin diversions. The majority of nodes with low riparian risk were in low-order, high-elevation streams.

For the Roaring Fork Basin, the WFET provides useful insight into the flow-related ecological risk. The primary output from the pilot is a series of relatively simple maps that clearly and quickly convey the ecological risk status for a range of ecosystem components. Such a watershed-wide perspective simply was not possible before. However, the tool is worth more than a picture. The Colorado Basin Roundtable (BRT) wants to estimate total basin-wide non-consumptive water needs. To this end, we used WFET results to provide a range of seasonal flow conditions that are associated with ecological risk levels. Using this range, we can estimate the volume of water needed to achieve specific ecological outcomes, as desired by the BRT.

The WFET also has other applications. For example, it can be used to target areas that need further site-specific studies, to support basin-wide assessments of project location and potential impacts, and to support strategic decision making about the system-wide operations of water systems to provide better ecological outcomes.

The WFET advances watershed-scale flow assessment, but it does not cover all aspects of stream ecology. For example, mapping of the riparian metric was limited to below 9,600 feet—the approximate upper limit of narrowleaf cottonwood plant communities. In future applications, we expect to partially address these shortcomings by incorporating sediment transport and geomorphological



This map shows risk to riparian plant communities due to flow alteration in the Roaring Fork Watershed. Low risk (green) was found in tributaries without diversions; moderate risk (orange) to high risk (red) was found below large in-basin and transbasin diversions.

considerations into flow-ecology relationships. Also, the WFET addresses only flow issues, while ecological function of a stream or river can be impaired by riparian management, poor water quality, the presence of non-native species, and other factors.

Even for the attributes covered, it would be preferable to conduct a comprehensive site-specific assessment at every WFET node. A detailed analysis is always preferable for determining flow management in a given stream segment. Similarly, the WFET will not replace the ecological and hydrological analyses needed during impact assessments (e.g., under the National Environmental Policy Act). Unfortunately, available resources greatly limit the number of places where detailed assessments can be done. The WFET is a useful approach for bridging the gap between available resources and need.

Collaboration and Wide Support is Key

The Roaring Fork pilot succeeded because several technical and social pieces were in place. Critically, a well-developed and vetted hydrologic model was available. We learned in Fountain Creek that without such a model, WFET application is highly constrained. But even good technical tools often fail if developed in isolation from a working social process. Fortunately, we had strong support from Colorado Water Conservation Board (CWCB) staff and Basin Roundtable members. This support ranged from guidance on detailed technical issues to providing big-picture feedback. And, of course, funding from the CWCB was essential.

The success of the WFET pilot in the Roaring Fork illustrates the potential value of ecologists and environmental advocates working collaboratively with other stakeholders, including state and federal agencies and water users. We believe this pilot can serve as a model for bringing good science to bear on water management decisions at a geographic scale heretofore not achieved in Colorado.

Acknowledgements

The technical team who developed the Roaring Fork WFET Pilot included Nicole Rowan and others at Camp Dresser & McKee, Inc.; Thomas Wilding, Brian Bledsoe, and LeRoy Poff, all at Colorado State University; and Bill Miller of Miller Ecological Consulting. The technical team benefited greatly from participation by Colorado Basin Roundtable members, particularly Lane Wyatt and Ken Neubecker. Support and guidance from the Colorado Water Conservation Board, especially Jacob Bornstein, was also essential to our work.

Non-Consumptive Needs Assessments in Today's Climate

by Jacob Bornstein, Program Manager, Colorado Water Conservation Board

It is my personal belief that altruism is one of the key characteristics of humankind, but that such motivations can only go so far. For this reason, it is only when self interest is involved, or in the least not impaired, that environmental and recreational needs will ultimately reach the same level of sophistication and maturity that more traditional beneficial uses have reached.

Several key factors are enabling environmental and recreational beneficial uses to become more refined. These include incentive-driven processes (e.g., the roundtable process), a more restrictive regulatory climate, and the growing practical and economic values associated with these attributes, including agriculture in some cases. This brief essay will cover each of these and then discuss what has been accomplished with the non-consumptive needs assessments and what is to come.

Roundtable Process

In 2006, Colorado's legislature determined that each basin roundtable should consider environmental and recreational (aka non-consumptive) needs. Specifically, H.B. 1177 asks each roundtable to "develop a basin-wide consumptive and non-consumptive water supply needs assessment, conduct an analysis of available unappropriated waters within the basin, and propose projects or methods, both structural and nonstructural, for meeting those needs."

Although much suspicion remains about accomplishing this task in relation to non-consumptive needs, since 2007 there has been give-and-take among water users, providers, agriculturalists, environmentalists, and recreationalists, which has led to dwindling suspicion. Each week I am surprised by how much more informed conversations have become. Increasingly, they are based on using the best available data to make an honest attempt to move the process forward in a reasonable, rather than obstructionist, manner.

One factor that has enabled us to get to this point is the legislation that created Water Supply Reserve Account (WSRA) grants. The continual give-and-take on water supply projects and studies helped build not only trust, but also the expectation that, in time, non-consumptive needs would also be considered. Similarly, the available funds allowed multi-purpose projects and studies, as well as environmentally or recreationally focused projects, to move forward. Examples range from partnerships with Ducks Unlimited and water users in the lower South Platte, to the Shared Vision Process with Halligan-Seaman Reservoir enlargements, to a series of conservation easements on the Rio Grande. In each case, non-consumptive and consumptive needs mutually benefited. Success is not simply built on altruism and trust; it also originates from real working relationships.

New Regulatory Climate

The very fact that the H.B. 1177 legislation included provisions for non-consumptive needs reflects a larger trend in the regulatory framework. Permitted projects that do not include mitigation or enhancement for non-consumptive needs are now the exception to the rule. One reason federal agencies cite for denying permits is that environmental considerations were not integral from the beginning of the project planning phase and, therefore, were not adequately addressed.

Most water providers recognize this. Denver Water believes that Two Forks provided a valuable lesson. Denver Water and Northern Water have proposed joint environmental mitigation and environmental enhancements for their current firming projects (Moffat Firming and Windy Gap Firming, respectively). Similarly, the Halligan-Seaman enlargement project is partnering with the environmental community to determine how to best *enhance* ecological attributes through operational management strategies.

While the Colorado Water Conservation Board (CWCB) tends not to support or oppose any individual projects, there is concern that no reasonable projects developed by local water providers will move forward, thus causing a larger and more immediate water supply "gap." While there will be impacts from water projects, we should also have concerns with continued transfer of water from irrigated agriculture to municipal and industrial uses.

Recent analysis determined that if we continue developing water through a business-as-usual approach, over 550,000 acres could be dried up by 2050—42% of South Platte agriculture and 33% of Arkansas agriculture. This would not only have a dramatic effect on the viability of Colorado's rural communities, but also on Colorado's environment. If permanent or rotational agricultural transfers are being proposed as alternatives to projects proposed by water providers, the socio-economic and environmental impacts of agricultural transfer should factor into any permit decisions.

The non-consumptive needs assessments can help by identifying non-consumptive needs upfront to support water supply project planning by local water providers. Basin roundtable efforts will help determine where non-consumptive and consumptive needs can benefit one another and where pinch points might be. In the pilot study results for the Watershed Flow Evaluation Tool (WFET), we already confirmed that "managed" flows below reservoirs can sometimes be more beneficial to certain environmental attributes, such as trout. The same is likely the case in areas where agricultural practices have altered flows for the last century, providing return flows for wetland-dependent bird species and larger base flow conditions for impaired minnows. It will be important to know if the failure of some of these projects could cause worse harm to the environment.

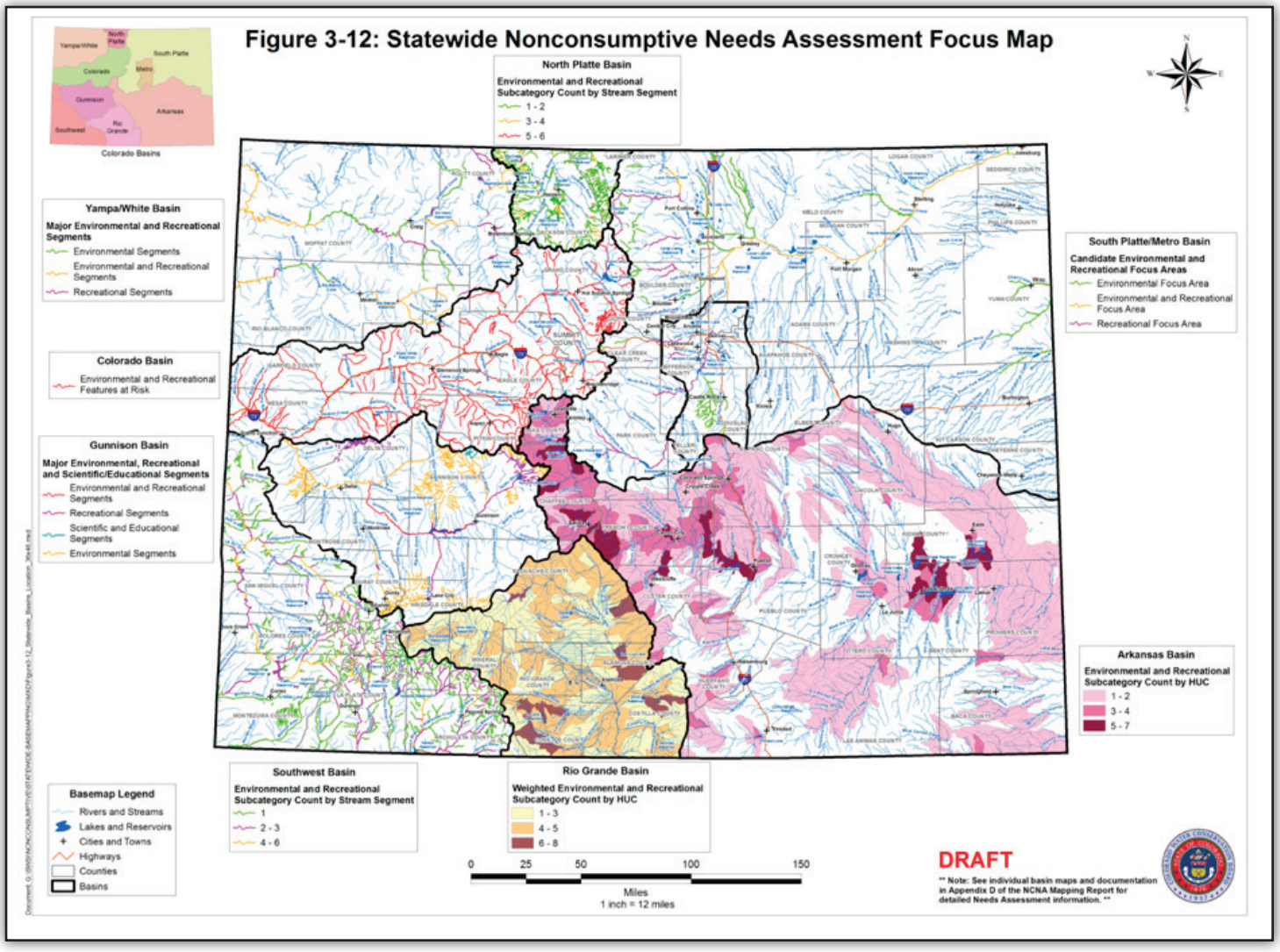
Practical Considerations

The potential linkage between agricultural and environmental interests is reflected in the roundtable and IBCC process. As economic and practical considerations continue to put pressure on agricultural communities, many farmers and ranchers have asked what impact drying up agriculture will have on the ecology of streams.

Environmental and agricultural interests may have a natural partnership that has yet to be fully realized, and determining how these two interface is critical to unwinding how Colorado can build a future vision that is attractive to all stakeholders. These practical considerations are also important in building a successful and meaningful non-consumptive needs assessment.

This goes beyond agriculture, too. Growing recognition that the reason people see Colorado as a desirable place to live is partly related to healthy stream systems and vibrant rafting, kayaking, and fishing economies. West Slope resort towns are largely dependent upon Front Range clientele enjoying these amenities. Similarly, proximity to West Slope amenities is often cited as a primary reason that large companies move their headquarters/operations to Colorado's Front Range. Again, a statewide view shows how interconnected Colorado's economies are, and how the economic values of environmental and recreational attributes are important to healthy communities statewide.

Together, the realities of working together more closely, a more restrictive regulatory framework, and increased recognition that non-consumptive needs and sustainable agriculture are linked and that our state's economy and identity is tied together by non-consumptive attributes,



may be creating a set of conditions under which the tools and methodologies associated with understanding and conserving non-consumptive needs can mature.

Non-Consumptive Needs Assessment

I believe that some of these reasons contributed to the approval by each of the nine basin roundtables of their non-consumptive need focus area maps. Details of this can be found in the July 2009 draft *Non-consumptive Needs Assessment Focus Mapping Report*, available on the CWCB web site. The statewide map depicted on the opposite page shows non-consumptive inventory/focus areas for all of the nine basin roundtables. This effort involved working with each of the basin roundtables and their respective subcommittees to assemble data on the non-consumptive resources in their basin, discussing options for mapping, presenting mapping results, integrating feedback, and assembling maps upon which all subcommittee members could agree. Throughout this iterative process, CWCB met with the basin roundtables or their non-consumptive subcommittees across the state more than 40 times.

Phase II of the non-consumptive needs assessment will involve working with basin roundtables to determine the status of each of the identified non-consumptive need areas by compiling all of the existing flow quantification studies and planned projects and methods. Those areas that do not have existing projects and methods to meet the non-consumptive needs are the non-consumptive "gap." The roundtables will discuss what, if anything, they would like to do as next steps in each of these areas. This will be done in coordination with the roundtables and will involve significant outreach to basin roundtable members and members of the environmental and recreational communities.

Some basins may choose to quantify flow using the Watershed Flow Evaluation Tool or other methods. The Colorado Basin Roundtable is using a WSRA grant to implement the WFET, and the Arkansas Basin is quantifying its additional non-consumptive needs using site-specific methods around John Martin and Neenoshe Reservoirs. These two approaches will provide a quantification of water supplies needed to meet environmental and recreational demands. Other basin roundtables may focus less on non-consumptive quantification and put their efforts into identifying projects or methods for meeting their non-consumptive needs.

Such broad-scale approaches to non-consumptive needs will be considered side-by-side with consumptive needs, whether within the context of the Colorado River Water Availability Study Phase II or the incorporation of non-consumptive projects and methods into the Basin Needs Decision Support System (formerly known as the IP&P database). These tools and processes will significantly move forward the ability to consider non-consumptive needs upfront in water supply planning.

The views and opinions expressed herein are not those of the state of Colorado, but rather those of the author.

A Platform for Assessing Ecological Condition of Colorado Watersheds

by David M. Theobald, Associate Professor, Department of Human Dimensions of Natural Resources; and John B. Norman, Research Associate, Natural Resource Ecology Lab; Colorado State University

Over the past five years, we have been building a platform that supports applications to better understand non-consumptive water uses—specifically, through assessments of ecological condition of watersheds in Colorado and the Rocky Mountain West. Originally, our work was motivated by the need to provide advanced statistical analyses of water quality for the U.S. Environmental Protection Agency's Science to Achieve Results Program. This effort resulted in establishing a platform of GIS-based tools and databases that we call FLoWS (Functional Linkage of Watersheds and Streams). More recently, we have refined this platform through collaborations with The Nature Conservancy, National Park Service, and U.S. Forest Service Rocky Mountain Research Station. A common goal of our collaborators has been to better understand the ecological and societal effects of important biological, land use, and climate-induced changes to hydrological systems.

Although Colorado has benefited from comprehensive decision support systems that assist water supply managers, often through interactive mapping systems, we have found the need to develop comprehensive, integrated spatial databases that represent important ecological processes and hydrologic flows that dominate freshwater ecosystems. In this article, we describe some technical challenges we have encountered and illustrate a few applications of our work.A relatively straightforward, but often daunting, challenge has been to fix errors in spatial data that represent stream networks. Although a number of federal agencies have recently coordinated to create massive improvements in the spatial data infrastructure for hydrologic systems (i.e., National Hydrography Dataset, Watershed Boundary Dataset, etc.), we have corrected a number of issues in maps that cause interruptions when modeling instream flow through the hydrologic network. These issues arise from simple errors in digitizing the stream lines (disconnected line segments), to gaps in stream lines below intersections with ditches, to false intersections of trans-basin diversions (pipelines) with surface streamlines.

To understand how events such as beetle outbreak, residential development, or drought modify upland portions of watersheds, thereby changing sediment deposition or the amount of toxic chemicals that may reach a stream, we

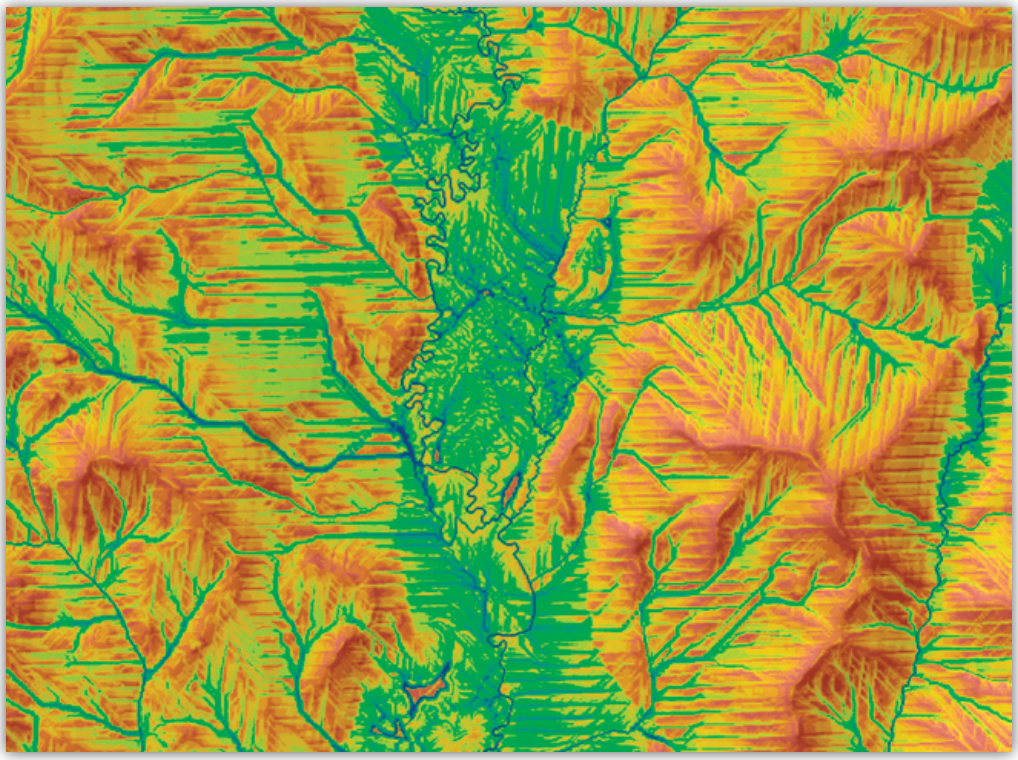


Figure 1: This map is an example of fusing "blue-line" stream lines from 1:24,000-scale topographic maps with 10-meter Digital Elevation Models to generate a surface to integrate overland flow and instream flow processes. Red areas depict relatively drier locations, while green to blue areas indicate moist soil conditions, for a portion of the Kawuneeche Valley, Rocky Mountain National Park, Colorado. (Courtesy of David Theobald and John Norman)

integrated the stream network with the representation of topography and land cover (i.e., overland flow process). We developed a hybrid approach to fuse stream line information with topography to generate a continuous representation of flow across the full surface of a watershed (Figure 1).

At a fine scale, we occasionally find misalignment between the broader land surface (represented by digital elevation models) and "blue-line" maps (streams from topographic quads), as well as artifacts that remain from the original mapping of streams, such as streams of different densities crossing a quadrangle boundary and identification of perennial vs. intermittent streams based on a historical climate regimes (Figure 2). We also have been challenged to model hydrology at a scale relevant for land managers (typically 1:24,000 or finer), both because most available datasets are at a coarser scale (i.e., 1:100,000) and because of the computational challenges of conducting network analyses with very large datasets (>1 million reaches). Finally, a number of broader challenges remain, such as inferring the likely distribution of fish species through a stream network based on a limited number of observations at discrete sites.

Currently, we are conducting watershed condition assessments in Colorado to examine the effects of a variety of landscape changes, including consequences of the expansion of residential growth, likely drying and warming due to climate change, and potential effects of beetle kill on watershed processes. Of critical importance

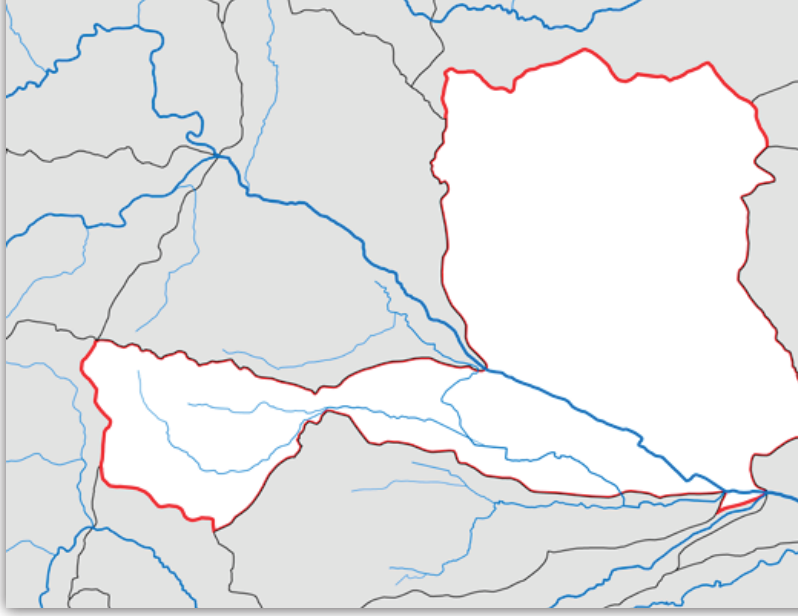
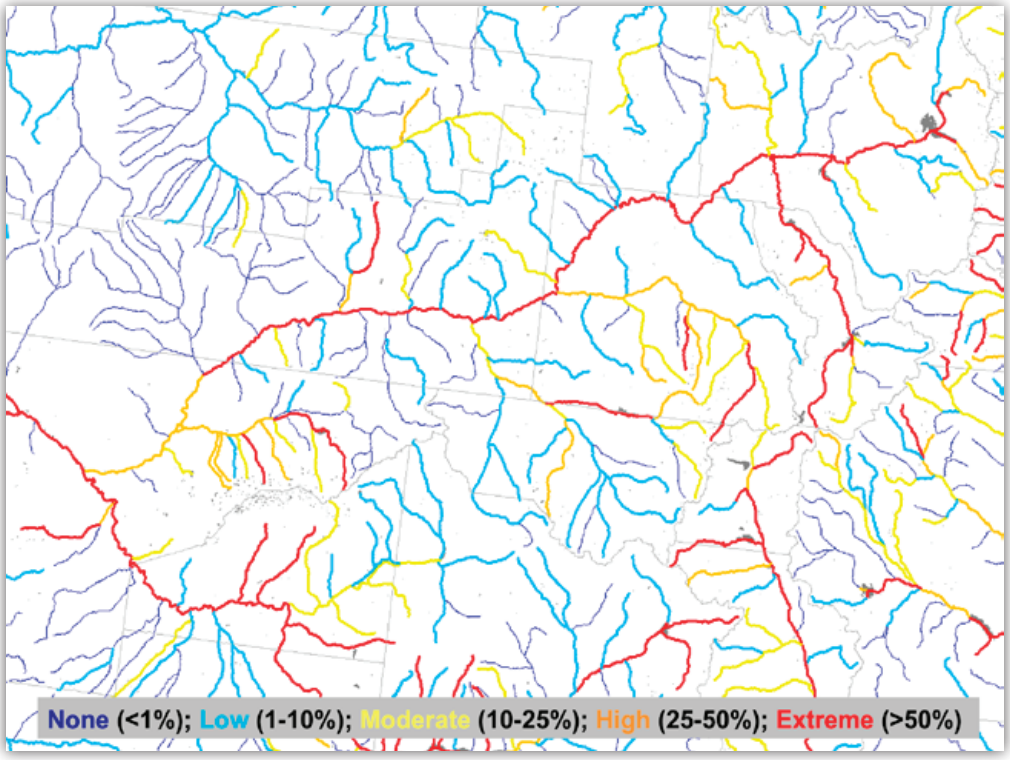


Figure 2: This map shows inconsistencies between stream lines (1:100k NHD) and watershed boundaries (1:24,000 WBD) for a portion of Colorado. Watershed boundaries are shown in black, while the red boundary is a watershed with a topological error. (Courtesy of David Theobald and John Norman)

is understanding the consequences of these changes within the existing water infrastructure context. For example, we have developed an indicator of flow fragmentation that measures the downstream cumulative effects and "shadows" of dams on ecological systems, which is computed as the ratio of reservoir storage area divided by the mean annual "virgin" discharge. We believe that continued investment in this platform helps us to move beyond mapping of hydrologic systems to incorporating ecological processes and likely scenarios of landscape changes.



This map shows flow modification of the Colorado River, which is computed as the ratio of the reservoir storage area divided by the mean annual "virgin" discharge. Large reservoirs are shown in grey. (Courtesy of David Theobald and John Norman)

Protecting Colorado's Natural Environment With Instream Flow and Natural Lake Level Water Rights

by Linda Bassi, Section Chief, Stream and Lake Protection Section, Colorado Water Conservation Board

ISF Program Overview

In the early 1970s, the environment was at the forefront of the nation's agenda, and Colorado's focus was no different. Colorado mountain streams were being tapped to meet urban water needs, and federal minimum bypass flow requirements at diversion structures were not protected from diversion past the point of bypass. In 1973, the Colorado legislature recognized the need to "correlate the activities of mankind with some reasonable preservation of the natural environment" and passed Senate Bill 97, creating Colorado's Instream Flow and Natural Lake Level Program (ISF Program). This program, one of the first of its kind, vested the Colorado Water Conservation Board (CWCB) with exclusive authority to protect stream flow through a reach of stream, and to protect levels in natural lakes.

Before SB 97, all appropriators of water in Colorado were required to divert water from its natural course in the stream. SB 97 removed the diversion requirement for the CWCB, authorizing it to appropriate non-consumptive water rights for natural lakes and reaches of stream for the purpose of preserving the natural environment to a reasonable degree. SB 97 also authorized the CWCB to acquire existing decreed water rights on a voluntary basis from willing owners for instream flow (ISF) use. In most cases, the CWCB must apply to water court to obtain a decreed right to use acquired water rights for ISF purposes. Once decreed by the water court, new ISF water rights and acquired water rights changed to ISF use are administered within the state's water right priority system.

Since 1973, Colorado has enacted additional legislation to clarify and strengthen the ISF Program. In 2001, legislation authorized the CWCB to use acquired water to improve the natural environment to a reasonable degree, expanding the CWCB's ability to protect and restore streams with acquired water. In 2007, the legislature clarified the CWCB's authority to accept temporary loans or leases of water for ISF use. In 2008, new legislation provided incentives to water rights owners to loan or lease their water rights to the CWCB for ISF use. This legislation assured water rights owners of no reduction in historical consumptive use credit for periods of ISF use of leased water rights in the context of a future change of water right proceeding. It also designated leases or loans of water rights to the CWCB for ISF use as a circumstance where no intent to abandon the water right shall be found.

To date, Colorado has appropriated ISF water rights covering over 8,500 miles of stream and 486 natural lakes, which represents approximately 30% of the state's perennial stream miles. In addition, the CWCB has completed 21 water acquisition transactions, including acquisitions to protect critical habitat for endangered species on the Yampa River, to improve the natural environment of the Blue River downstream from Dillon Reservoir, and to restore native flows to a degraded stream system near Silverton, Colorado. The CWCB currently is considering a proposed long-term agreement with Pitkin County to use certain county-owned water rights for ISF protection in the Roaring Fork River and its tributaries.

Balancing human needs with the needs of the environment can be a difficult task; providing legal protection for environmental needs can be even more challenging. Rather than creating a "super" right or mandating bypass flows, Colorado's system of integrating ISF flow water rights into the state's water right allocation system places these water rights on an even plane with traditional, consumptive water uses. ISF water rights are permanent, fully adjudicated water rights that are administered as any other water right in the state, consistent with Colorado's prior appropriation doctrine. These rights protect flows through a reach of stream, not just at a bypass point, and have legal standing in water court to protect against injury at any point within the ISF reach.

Under state water law, adjudicated water rights are entitled to stream conditions as they existed at the time of appropriation. Junior priority ISF water rights cannot affect operation of senior decreed water rights. However, if a change of water right is sought for a senior water right, CWCB has standing in water court to ensure that stream conditions are not altered to the detriment of decreed ISF water rights. The CWCB files statements of opposition to potentially injurious water court applications with the goal of including protective terms and conditions in water court applicants' decrees. The CWCB has successfully negotiated terms and conditions to ensure its ISF water rights are protected in over 99% of the cases it has entered, thereby enabling the applicant to proceed with its proposed water use and the stream to be protected.

Monitoring, Protection, and Enforcement of ISF Water Rights

Once an ISF water right is decreed, it is important to monitor stream flows to ensure that the right is being fully met and to protect the right from potential injury that may result from subsequent claims for water from the same stream system. Enforcement of the CWCB's ISF water rights is accomplished through both physical and legal protection strategies.

Physical protection for decreed ISF water rights begins with the monitoring of stream flows on critical stream reaches. CWCB staff accomplishes this task by using a network of stream gages operated and maintained by the U.S. Geological Survey (USGS), Division of Water Resources (DWR), CWCB, and others. Many of these gages are linked via satellite telemetry and provide real-time data to staff and other stakeholders. CWCB and DWR staff have developed a low flow alert system to notify staff by email and cell phone if streamflows drop below decreed ISF amounts on critical stream reaches. When a low flow condition is identified, CWCB staff will contact the Division Engineer to determine whether the ISF water right is in priority and entitled to receive water. If so, CWCB staff will place a call for enforcement of the water right with the Division Engineer, who may curtail junior rights diverting out-of-priority to satisfy the call.

Although many stream reaches can be monitored and protected by this sophisticated alert system, it is important to note that this stream gaging technology is present on only a fraction of the streams with decreed ISF water rights. In many locations, there are no stream gages, or the gages that exist must be observed and read manually. Fortunately, many stakeholders and individuals interested in ISF water rights often will report low flow conditions to CWCB staff for investigation. Staff follows through on all reported low flow incidents but can only request administration if a measurement device is in place. However, such incidents are useful in identifying decreed ISF stream reaches that could benefit from administration if a gage were installed. Staff has been collaborating with the State and Division Engineers to further identify locations for the installation of administrative gages. In 2007, legislation providing annual funding to the CWCB for installing measuring devices in strategic locations enhanced staff's ability to monitor and protect ISF water rights. The CWCB now has a hydrographer on its staff to install, operate, and maintain stream gages, and to coordinate with the DWR, USGS, and others on those activities.

Legal protection of ISF and natural lake level water rights begins with the monthly resume review of every water right application in all seven water divisions. CWCB staff uses GIS mapping tools, water right databases, and other information to locate each claim and evaluate the potential for injury. If a potential injury to ISF water rights is identified, the CWCB files a statement of opposition with the water court, and staff—represented by the Attorney General's Office—works with the applicants to develop terms and conditions that will protect the ISF or natural lake level water rights from injury while allowing the proposed water right activity to proceed. If the CWCB is unable to reach a stipulated settlement, the CWCB may pursue litigation. Injury to ISF water rights can result from many different water right activities; however, the most common forms of injury involve changes of water rights that move the point of diversion upstream or potentially expand the use of the water right to be changed; and plans for augmentation in which the augmentation source is inadequate or located downstream of an ISF water right.

Ongoing ISF Program Activities

The ISF Program can play an important role in achieving the goals of several ongoing collaborative efforts by: (1) protecting flow-related Outstandingly Remarkable Values as part of a negotiated alternative management plan on rivers and streams being considered for Wild and Scenic designation; (2) achieving federal agencies' resource protection goals on streams in wilderness areas, such as the recently designated Dominguez Canyons Wilderness Area; and (3) assisting in meeting non-consumptive needs identified by the Basin Roundtables. CWCB staff participates in these processes with the hope that the ISF Program can contribute to their success.

For more information on the ISF Program, go to http://cwcb.state.co.us/StreamAndLake/.

This image shows Maroon Creek, upstream of its confluence with the Roaring Fork River in Pitkin County. (Courtesy of Colorado Water Conservation Board)

Competing Uses for Reservoir Water: Where Do Fish and Fisheries Fit In?

by Brett Johnson, Professor, Department of Fish, Wildlife and Conservation Biology, Colorado State University

Historically, western reservoirs have been viewed as vessels for capturing and storing a valuable commodity. This view predominates today where water is an increasingly precious resource serving a variety of human needs. Terminology reveals society's prevailing attitude that reservoirs are created for utilitarian purposes with little or no regard for the aquatic ecosystem that is born when a dam is closed. We refer to reservoir capacity in "acre-feet" (one acre-foot is the amount of water that could cover an acre of agricultural field to a depth of one foot). "Spills" are scrupulously avoided because when they occur, water flows uselessly over the top of the dam instead of through power generating turbines. "Teacup diagrams" display how full a reservoir is relative to its capacity. The "active storage" is the amount of water in a reservoir that can be used for power generation or for other downstream uses. Interestingly, the term "dead storage" (stored water that cannot be evacuated by gravity) suggests that water that cannot be taken from a reservoir for humans is useless and, therefore, dead. All these terms strongly suggest that water in reservoirs is there for a purpose: it is waiting to be used by humans.

It is certainly true that the vast majority of dams built in the West were constructed at tremendous expense with the explicit purpose of providing for utilitarian, mostly consumptive uses of the water they captured. Hydropower revenues and the economic benefits derived from agricultural, municipal, and other commercial uses of stored water were an inherent expectation as payback for society's investment in building and operating dams.

Today, downstream commercial demand for reservoir water is increasing. But so is society's demand for non-consumptive uses of that water. These non-consumptive uses include environmental flows that benefit river ecosystems and the fish and fisheries they support, and the provision of habitat for fish communities and fisheries that have become established within reservoirs. Quantifying these non-market values is not straightforward, and we cannot easily express their societal benefits in dollars per acre-foot. Thus, in the competition for reservoir water, unless endangered species are involved, demands for non-consumptive uses aimed at supporting fish and fisheries have usually taken very low priority in reservoir operating plans.

Reservoirs and their operations can have a tremendous influence on fish and fisheries. In many cases the very existence of reservoirs provides for a diversification of fish species found in a locale. In the West, dams have created large lake-like habitats that were extremely rare prior to the 20th century. This provided environments that were foreign—even inhospitable—to the native fishes, but quite favorable to dozens of nonnative sport and forage fishes, which spawned the development of popular and valuable fisheries.

In Colorado, the shallow productive reservoirs on the eastern plains support fast-growing populations of walleye and wiper (striped bass x white bass hybrids). Along the Front Range, where reservoirs can provide warmwater habitat on the surface and coldwater habitat in deeper waters, "two-story fisheries" are the rule. In these reservoirs, fish like bass and walleye inhabit the upper floors and trout and kokanee reside downstairs. Above about 7,000 feet in elevation, reservoirs are dominated by lake trout and kokanee, though northern pike and walleye may occur, particularly if illegally transplanted from lower elevation waters. Rainbow trout are a rather cosmopolitan species in Colorado that can be found in almost any region of the state. Below large dams with deepwater outlets, the temperature of the outflow is cold in summer and relatively warm in winter, supporting optimum conditions for nonnative trout where only native nongame species existed before.

While the construction of large dams created a haven for popular sport fish and fisheries, many reservoir sport fish populations in Colorado are sustained by stocking because typical dam operations make natural reproduction problematic. Reservoir conditions can be unsuitable for reproduction because of water level fluctuation during egg incubation and poor substrate condition (fine sediments). Reservoir drawdown in winter to make room for spring snowmelt can leave the eggs of fall spawning species (e.g., lake trout and kokanee) high and dry before they hatch. Unstable water levels in spring and early summer can inundate unsuitable spawning habitat or increase turbidity in the shallow waters used for egg laying and nesting by many other species. The large releases needed to supply downstream water users in summer can flush out young reservoir fish that are unable to resist the downstream flow. Thus, you can probably imagine that if sport fish managers were at the controls, dams might be operated quite differently than they are now.

But what about the native fish—the ones that had inhabited the rivers for millions of years before the first dam was built? How have dams and dam operations

affected these species? Colorado's native fishes are mostly river specialists, some adapted for big West Slope rivers that once were turbid, warm, and flashy (e.g., bonytail, Colorado pikeminnow), and others living in networks of smaller montane streams (e.g., Colorado River cutthroat trout). Changes to the aquatic landscape when rivers were dammed have been extreme and unfavorable for most native fish.

At a geographic level, dams are barriers to migration, or more aptly, they are one-way valves allowing fish to move only downstream. Reservoirs themselves can be barriers that prevent native fish from moving among tributaries and maintaining healthy gene flow within and among populations. Dams and their traditional operating patterns have enormous physical and chemical impacts to rivers, often making them entirely unsuitable for native fish for many miles downstream. Scientists refer to the hydrology of a pristine river as the "natural flow regime," which supports the entire ecosystem's physical, chemical, and biological integrity and function. Human needs for river water have disrupted the natural flow regime in most watersheds—not just in Colorado but nationwide, where more than 90% of the country's river flow is altered by dams and diversions.

Unfortunately, human needs for water are growing faster than are accessible water supplies. As demand for consumptive, commercial uses of water in Colorado grows, so does the complexity of dam operating regimes that can meet these demands while still providing for some of society's water-related values. Fishery scientists are being challenged to develop fishery management strategies that are more sustainable, given the realities of increased water demand and the recognition that some sport fisheries are incompatible with the persistence of native fishes. Water providers may find that partnering with sport fish managers, native species advocates, and other sectors of the water user community will be the most effective way to navigate a future in which water will become an increasingly precious resource serving a wide spectrum of human needs and desires.

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Helping Endangered Fishes through Nonnative Fish Management

by Tom Chart, *Director, Upper Colorado River Endangered Fish Recovery Program*

When human activities alter the species present in an ecosystem, results can be disastrous. Introduced nonnative fish species, like smallmouth bass and northern pike, pose a serious threat to four species of big-river fishes—the endangered humpback chub, bonytail, Colorado pikeminnow, and razorback sucker. The Upper Colorado River Endangered Fish Recovery Program (Recovery Program) is undertaking a major effort to manage nonnative fish species and recover the endangered fishes.

Recovery Program Background

The Recovery Program is a unique partnership established in 1988 to recover the endangered fishes in the Upper Colorado River Basin while water use and development continues in accordance with federal and state laws and interstate compacts. Partners include the States of Colorado, Utah, and Wyoming; U.S. Fish and Wildlife Service; National Park Service; Bureau of Reclamation; Western Area Power Administration; Colorado River Energy Distributors Association; and water user and environmental organizations.

Historically, these unique long-lived fishes occurred throughout the warmwater reaches of the Colorado River Basin from Wyoming to Mexico. Their habitat and numbers declined significantly over the last century as hundreds of dams were constructed, river flows were reduced by about a third, and numerous nonnative fish species were introduced.

When the Recovery Program began, partners assumed that providing adequate instream flows would be the greatest challenge to recovery. Although this has indeed been a big task, water users, biologists, agency personnel, and others pulled together to implement significant improvements and to secure agreements to provide flows for the endangered fishes.

Program partners also worked to implement other elements key to achieving recovery. These include habitat development (constructing passage around dams to provide fish access to historic habitat, constructing fish screens to prevent fish from getting trapped in irrigation canals, and restoring floodplain habitats for the fish), raising and stocking endangered fish, conducting research and monitoring, and managing nonnative fish populations.

Rick Smaniotto, biologist with the U.S. Fish and Wildlife Service, holds a Colorado pikeminnow. Populations of nonnative northern pike have increased in critical Colorado pikeminnow habitat in the Yampa River. (Courtesy of U.S. Fish and Wildlife Service)

The razorback sucker is one of four endangered fish species threatened by nonnative fish in the Upper Colorado River Basin. (Courtesy of Colorado Division of Wildlife)

Nonnative Fish

Predation or competition by nonnative fishes is a serious threat to the endangered fishes and currently poses the biggest obstacle to their recovery. Only 14 species or subspecies of native fish occurred historically in the upper basin. Over the past 100 years, more than 50 nonnative fish species have been introduced in the upper basin.

While people and endangered fishes shared water shortages throughout the recent drought, some populations of introduced nonnative fish species began to explode. Today, the Recovery Program's greatest challenge is reducing nonnative fish populations to the point where they don't impede efforts to recover the endangered fishes.

The Recovery Program's early nonnative fish management activities focused on regulating stocking, screening reservoir outlets, and changing fishing regulations to increase nonnative fish harvest. Biologists also worked to manage nonnative fishes through direct removal. Early target species were channel catfish, nonnative minnows, and sunfishes, but efforts to control these species were largely ineffective. Biologists removed channel catfish via nets and electrofishing but discovered that the fish were difficult to collect in sufficient numbers to have a lasting, measurable effect. However, some positive results occurred in Yampa Canyon with the removal of adult and subadult channel catfish.

Small-bodied nonnative cyprinids (or minnows) comprise up to 99.9% of the fish community in some places. The Recovery Program attempted to manage these fishes by seining them out of backwater habitats in the spring and summer to reduce competition with, and predation on, young razorback sucker and Colorado pikeminnow. These areas were quickly re-populated by nonnative cyprinids from the main channel, and biologists again found that their efforts had no measurable, lasting effect.

Centrarchids (e.g., sunfish and bass) are also a threat. The Recovery Program tried to remove them from off-channel ponds with connections to the river; however, most of the ponds were rapidly re-populated. This work has transitioned into microchemistry investigations to determine the sources of nonnative fishes.

From the 1990s through 2002, the Recovery Program continued channel catfish work in the Yampa River and began work to manage northern pike in the Yampa and Green Rivers. At this point, smallmouth bass were not abundant.

Then came the bad news. Study results from 2001 showed that young native fish (roundtail chub, flannelmouth sucker, and bluehead sucker) had disappeared from the Yampa River where smallmouth bass populations began to explode. In contrast, the same species remained in the Colorado River where smallmouth bass were relatively scarce. This sounded the alarm about the overall status of the native fish community in the Yampa River in light of increasing smallmouth bass numbers. Other native fish species were similarly diminished.

Smallmouth bass and northern pike populations continue to expand and are now the species of greatest concern. The Recovery Program currently spends about $1.5 million per year to manage nonnative fishes.

Smallmouth Bass

The major source of smallmouth bass in the Yampa River was Elkhead Reservoir in the early 1990s during an unscreened and rapid release of water. The smallmouth bass population expanded and boomed from 2000-2003,

The Colorado pikeminnow is one of four endangered fish species threatened by nonnative fish in the Upper Colorado River Basin. (Courtesy of Joe Ferreira)

Researcher Jake Johnson holds a northern pike. Populations of northern pike continue to increase in the Upper Colorado River Basin and are now of great concern. (Courtesy of Upper Colorado River Endangered Fish Recovery Program)

coinciding with a period of drought. Smallmouth bass also are fairly abundant in the Green River down to Gray Canyon, and they also occur in the Colorado River, but in much lower densities.

To manage these populations, biologists target adult and juvenile fish with shoreline electrofishing. Young fish are targeted with electric seines through 15-20 miles of the Yampa River during base flows. Biologists begin each season with a population estimate, then attempt to conduct enough electrofishing passes to remove 65% of the population annually. Modeling shows that a minimum of 65% "exploitation rate" each year for 10-20 years is needed to cause the smallmouth bass population to crash. If the numbers of smallmouth bass could be reduced to no more than 30 adults per river mile, the native fish may come back. Smallmouth bass removed from the Yampa River upstream of Yampa Canyon that are larger than 10 inches are relocated to ponds where they are accessible to anglers.

Although annual population estimates indicate that smallmouth bass numbers have been reduced in certain places, this is not the case in the highest density locations (e.g., Little Yampa Canyon [river mile 124-100] and Lily Park [river mile 55-50]).

Yampa River flows in 2008 and 2009 were cooler and wetter than in previous years, and this appears to have suppressed and delayed smallmouth bass reproduction. These data indicate that the best way to reduce smallmouth bass populations is to combine mechanical removal of adult and juvenile fish during cooler, wetter years.

Northern Pike

Distribution of northern pike is much more localized and confined. Numbers were reduced after one year of removal and have remained low ever since. Northern pike that remain in the Green River originate from the Yampa River, where the Recovery Program is working to manage northern pike in more than 150 river miles from Hayden, Colorado, to the Green River confluence.

Downstream from Craig, Colorado, biologists see little northern pike reproduction. The source of northern pike in the Yampa River is Catamount Reservoir and upstream. The Colorado Division of Wildlife is working to reduce northern pike numbers in these areas to help the Recovery Program achieve an interim target of three adult northern pike per river mile in Colorado pikeminnow critical habitat downstream of Craig. Although removal efforts downstream have resulted in smaller-sized northern pike and reduced northern pike migration from the Yampa River to the Green River, more work is needed to reduce northern pike recruitment from upstream sources to reach the three-fish-per-mile target.

Other Concerns

Biologists remain on the alert for other exotic species that may threaten the endangered fishes. Increasing numbers of adult walleye in the Green River and juvenile largemouth bass in the Colorado River are reason for concern. Increasing numbers of northern pike in Elkhead Reservoir may pose an escapement risk. Burbot (ling cod) have become established in Flaming Gorge Reservoir. Gizzard shad flared up in both the Green and Colorado Rivers in 2007 but declined in 2008. Hybridization with the nonnative white sucker is a potential threat to the endangered razorback sucker. And fish aren't the only concern. Quagga mussels may become an issue in some habitats, and facilities and nonnative crayfish could compete with endangered fishes for food.

Conclusion

Managing nonnative fishes is currently the Recovery Program's most significant challenge and demands herculean efforts from Program partners. While some progress has been made, more work and new techniques are needed before this problem is solved. The Recovery Program has made great strides using cooperative efforts to manage water to benefit the endangered fishes. Similar cooperation is underway and is essential to reducing nonnative fishes to a level that will not impede recovery of the endangered fishes.

For more information, visit the Recovery Program's web site: ColoradoRiverRecovery.org or call 303-969-7322, ext. 227.

The Right to Float in Colorado: Differing Perspectives

Editor's Note: *River running has become one of the most popular forms of recreation in Colorado, yet some believe that state law regarding the right to float through privately owned property is not well defined. This perceived ambiguity has prompted several lawsuits between outfitter companies and private land owners, and the stage is set for future legal entanglements related to this issue. In this article, we present the differing perspectives of two legal experts in Colorado: John R. Hill, attorney and shareholder in the firm of Bratton Hill Wilderson & Lock, LLC; and Lori Potter, attorney with Kaplan Kirsch & Rockwell LLP. In sharing their perspectives and expertise, both authors were asked to respond to the following questions:*

1. *What does Colorado law (both statute and case law) say about the right to float in Colorado?*
2. *Are there issues regarding the right to float that are still open to interpretation? If yes, which issues and why?*
3. *Do you have any stories you can share that will help readers understand the issues?*

John R. Hill: a shareholder in the firm of Bratton Hill Wilderson & Lock, LLC, in Gunnison, Colorado. He holds a B.S. from the U.S. Military Academy at West Point, a M.S. in Civil Engineering from Stanford, and a J.D. from George Washington University.

What does Colorado water law (both statute and case law) say about the right to float in Colorado?

There is no right to float. The Colorado Supreme Court in *People v. Emmert* held that "the land underlying non-navigable streams is the subject of private ownership and is vested in the proprietors of the adjoining lands" and "the public has no right to the use of waters overlying private lands for recreational purposes without the consent of the owner." There is no reported case holding any Colorado stream navigable. C.R.S. § 41-1-107 provides that "[t]he ownership of space above the lands and waters of this state is declared to be vested in the several owners of the surface beneath, subject to the right of flight of aircraft." No Colorado statute expressly confers a right on the public to float through private property. To the contrary, when the Colorado Supreme Court in *People v. Emmert* held that the public has no right to use the waters overlying private lands without the consent of the owner, it also found support in several statutes noting that such statutes imply legislative recognition of the right of the land owner to deny or limit access to his land and water.

Proponents of the right to float often argue that C.R.S. § 18-9-107, which provides in pertinent part that one who "without legal privilege . . . obstructs a highway, street, sidewalk, railway, waterway, building entrance, elevator, aisle, stairway, or hallway to which the public . . . has access" commits a crime. On its face, the statute does not create any rights, it simply makes it a crime to obstruct any waterway "to which the public has access." "Access" necessarily means legal access, which the public does not have over private land. The General Assembly could not have intended to make it a crime for a landowner to obstruct a waterway by using his airspace to construct a fence or bridge, thereby making a rancher a criminal for fencing across a stream to keep cattle from straying off his land. That would be an unconstitutional taking of the landowner's immediately enveloping airspace and his right to exclude others.

Are there issues regarding the right to float that are still open to interpretation? If yes, which issues and why?

There are no such issues. The law was and remains settled by *Emmert*. The question the Court decided was whether section 5, Article XVI, of the Colorado Constitution gave the public the right to float through private property. Therefore, the Court's holding is universally applicable, notwithstanding the fact that it was made in the criminal context. Proponents will also argue that a 1977 Attorney General's opinion by then Attorney General Duane Woodard found a public right by stating that C.R.S. § 18-4-504.5 defining "premises" for purposes of the criminal trespass statute did not authorize land owners to control floating through their property. Aside from the fact that attorney generals' opinions do not bind courts or law enforcement officers, that statement is wrong. The General Assembly does not have to authorize property owners to keep others off their property. The United States Supreme Court has held that the right to exclude others is inherent in the right to own property, as well as one of the most important attributes of that right. Also, in a recent case in Gunnison County, the district court ruled that C.R.S. § 18-4-504.5 is not a defense to civil trespass. That ruling is well-reasoned and, while not precedent, should be followed by other courts[1].

Of equal importance, any statute now in existence or that may be enacted in the future opening streams flowing through private land to public use would violate the Fifth Amendment to the United States Constitution if it

did not provide for payment of just compensation to the landowner.

One fact proponents choose to ignore is the fact that the Supreme Court has stated that the landowner has the right to the immediately enveloping airspace. The landowners use their airspace over the streams and stream beds for fences and bridges.

Proponents also make much of the positive financial impact from commercial rafting revenues in arguing that there is a general right to float the streams of Colorado flowing through private land. They ignore the fact that the landowners pay taxes on the land supporting their industry and that the rafters are using it for free.

Finally, it is possible, but not probable, that one or more Colorado streams may be navigable as a matter of federal law[2]. A detailed discussion of the various theories under which a water body may be navigable as a matter of federal law is beyond the scope of this article. However, the characteristics of Colorado streams that make them attractive to whitewater enthusiasts also make it unlikely that they are navigable under any traditional test. A century ago, the Colorado Supreme Court stated that there are no navigable streams in Colorado. Those opinions are subject to criticism for containing no legal analysis. However, they do reflect the common knowledge of that time that no streams were being used in commerce. There are no other cases that support any stream in Colorado being navigable under any theory.

Do you have any good stories you can share that will help readers understand the issues?

In 2001, I represented a landowner on the Lake Fork Gunnison River in a suit for trespass against a commercial rafting company. After the court ruled that the statute defining premises in the attorney general's opinion discussed above was not a defense to civil trespass, the defendant ultimately confessed judgment and went out of business.

[1] In contrast, there is a half century-old unreported district court ruling from Gunnison County that the Gunnison River is navigable from Almont to Sapinero. The district judge provided no analysis or cited no legal authority for his opinion and ignored the two Colorado Supreme Court opinions from the early 1900s discussed below holding that there were no navigable streams in Colorado. While those opinions are also subject to criticism for also containing no analysis, the district judge was obligated to explain why he did not follow them. The case was also a stipulated settlement, which binds only the parties and carries no precedential value.

[2] The U.S. Army Corps of Engineers considers the Colorado River downstream of Grand Junction to the Utah line and Navajo Reservoir as navigable waters of the United States.

Lori Potter: a Denver attorney who has represented river outfitters associations, rafting companies, and private boaters in cases involving the right to float (including the Cannibal Outdoors and Colorado Whitewater Association cases mentioned below). She can be reached at lpotter@kaplankirsch.com

Introduction

More people—over 500,000 in 2007 and 2008—take commercial whitewater raft trips in Colorado than in any other state. Commercial rafting powers Colorado's summer tourism economy. Private recreational boating also draws countless kayakers, canoeists, and rafters to the rivers and streams of Colorado every year. In fact, the state is named for one of its mightiest and most boatable rivers.

Despite the popularity of the state's waterways, the right of public boaters to float rivers as they run through private property in Colorado is frustratingly unclear. Thirty years ago, the Colorado Supreme Court concluded in a criminal trespass case under a now-superseded law that the public has no constitutional right to touch the bed or banks of a non-navigable river that overlies private lands. However, that decision ("Emmert") raises far more questions than it answers. Don't citizens have a right to float on navigable waters? What if a boater does not touch the river's bed or banks? The Emmert case was a criminal one; what happens when no one brings criminal charges? Almost every other state in the country recognizes and protects a boater's right to float through private property; surely there is a good answer for Colorado.

The Law of the Current in Colorado

Long before David Emmert decided to test the limits of the right to float by touching the bed of the Colorado River, another boater brought a test case, *Arnett v. Trouthaven*, on the Gunnison River. The Gunnison boater won a ruling from the state district court that said, based on historical use by rafts and boats, the Gunnison River from Almont to Cimarron is a navigable stream and its waters are open to the public. Proof of navigability was the key to this precedent, and even in 1961—years before the widespread popularity of commercial whitewater float trips—the court found sufficient evidence to support navigability and thus a public right to float.

As private and commercial rafting grew in popularity, there were more incidents of streamside landowners calling the sheriff when boaters floated through. At times, boaters needed to get out of their boats to portage around fencing erected across a river to control livestock. At other

times, floaters left their boats to fish or simply to picnic or relax on the banks. Some of the incidents involved boating through stream reaches that contained prized trout fisheries. The Emmert case was designed to test the constitutionality of the law that made the touching of the river bed a criminal trespass.

The Emmert float trip in 1976 began with a put-in on public land and continued through a private ranch that the boaters knew to oppose raft trips. Emmert deliberately touched the river bed and then floated under a strand of barbed wire strung to catch boaters. The rancher had the sheriff waiting on the other side to arrest Emmert for trespass.

Emmert argued in court that Colorado boaters have a right under the state constitution to float on the state's rivers. Colorado's constitution declares the water of every natural stream to be the property of the public, dedicated to the people's use. The Supreme Courts of Wyoming, Montana, and New Mexico had approved the right to float through private land based on nearly identical text in their state constitutions. The Colorado Supreme Court parted ways with neighboring states, holding that the constitution protects only the right of appropriation of water.

Meanwhile, however, the Colorado legislature reacted to Emmert's trespass conviction with disapproval and, with an alacrity that legislatures are not known for, amended the criminal trespass law. Henceforth, boaters who floated through private property but remained in their boats could not be charged with criminal trespass. The hearings on the amendment contained strong statements supporting the right to float. A formal opinion by Colorado's then-attorney general, Duane Woodard, stated that this immunity from liability extended to charges of civil trespass as well.

There continued to be the occasional flare-up along stretches of floatable water on private land. The South Platte River above Denver, prized by both fishing clubs and kayakers, is an example. Boaters secured a victory on at least a segment of that waterway when a landowner who had historically placed barriers in the river agreed that the Colorado Whitewater Association had established a right to float by more than 20 years of persistent use. The owner settled a lawsuit by formally granting that easement.

In 2001, a landowner along the Lake Fork Gunnison River demanded an end to float trips run by a husband and wife outfitting team known as Cannibal Outdoors. Despite operating under a federal permit and having a long history of running small, family-friendly trips on this quiet stretch of water near Lake City, Cannibal found itself defending a civil trespass complaint in state court. The outfitter was forced out of business by the cost and stress of the lawsuit before it could get a court ruling on the river's navigability.

The court issued a partial ruling, holding that the state's abolition of criminal trespass liability did not resolve the question of whether civil trespass liability still remains.

Where Things Stand

What, then, is the state of the law on the right to float in Colorado? It is widely agreed that no criminal liability exists for floaters who remain in their boats and do not touch the bed or banks; sheriff's tickets issued to them are usually dismissed. Boaters who do touch the bed or banks of a private owner may be cited, but they have raised a choice-of-evils defense to trespass where their contact was a direct result of fencing or another hazard in the water.

On the civil trespass side, the status of the law is about as clear as the water of a mighty river at the height of spring runoff. Navigability continues to be the basis on which boaters who put in on public land are entitled to float a river as it passes through private land. No fewer than 42 other states sustain the right to float in those circumstances, as did the state district court in Gunnison in the 1961 Arnett case, but no higher court in Colorado has yet weighed in. Navigability remains a complicated concept because it has at least three different definitions, but its central proposition is that proof of the use of a waterway for transportation renders it available to boaters for float trips today. The Emmert case is widely cited in opposition to a right to float based on navigability, but Emmert explicitly did not decide that legal issue because the parties stipulated that the river was not navigable.

Floating Downstream or Paddling Against the Current?

The two most common flashpoints involve (1) float trips through riverside subdivision developments marketed as exclusive second home sites, and (2) float trips through waters where fishing clubs or leases are maintained. Where the streamside land owner is absentee, as is often the case, the conflict takes on an additional dimension. The loss of commercial rafting revenue or, as in the Cannibal case, the loss of an operating business, to say nothing of the loss of a prized recreational opportunity, is a heavy price for a tourism- and recreation-driven economy to pay.

The status quo is hardly satisfactory if streamside landowners can use the mere threat of a civil trespass lawsuit to force longstanding river runners to cease river trips rather than face crushing legal costs and possible damage awards. Colorado's neighboring states with river-running opportunities have protected the right to float, notwithstanding those states' unquestioned sensitivity to private property interests. When presented with a new right to float case, Colorado courts will have a chance to follow suit.

The Connection between Environmental Concern and Outdoor Recreation: The Case of Fly Fishing

by Alan D. Bright, Associate Professor, Department of Human Dimensions of Natural Resources, CSU

A prominent issue for researchers in the human dimensions of natural resources is the level of concern the public has for the environment. Such concern may translate into support or opposition to many different environmental and natural resource initiatives. One factor that may influence a person's concern for the environment is participation in outdoor recreation activities, which exposes people to instances of environmental degradation where they recreate and increases their concern about such degradation on a broader scale. While this may appear to be intuitive, research results on the connection between environmental concern and outdoor recreation participation have been mixed.

Early research found that people who participated in non-consumptive outdoor recreation activities, such as backpacking and wildlife viewing, had a higher level of environmental concern than people who participated in consumptive activities such as hunting and fishing. However, none of the correlations reported were particularly significant. Other research has failed to find any connection between outdoor recreation participation. Finally, several researchers, while finding a positive relationship between pro-environmental behavior and outdoor recreation activity, also found that non-consumptive recreationists did not exhibit more pro-environmental behavior than did consumptive recreationists.

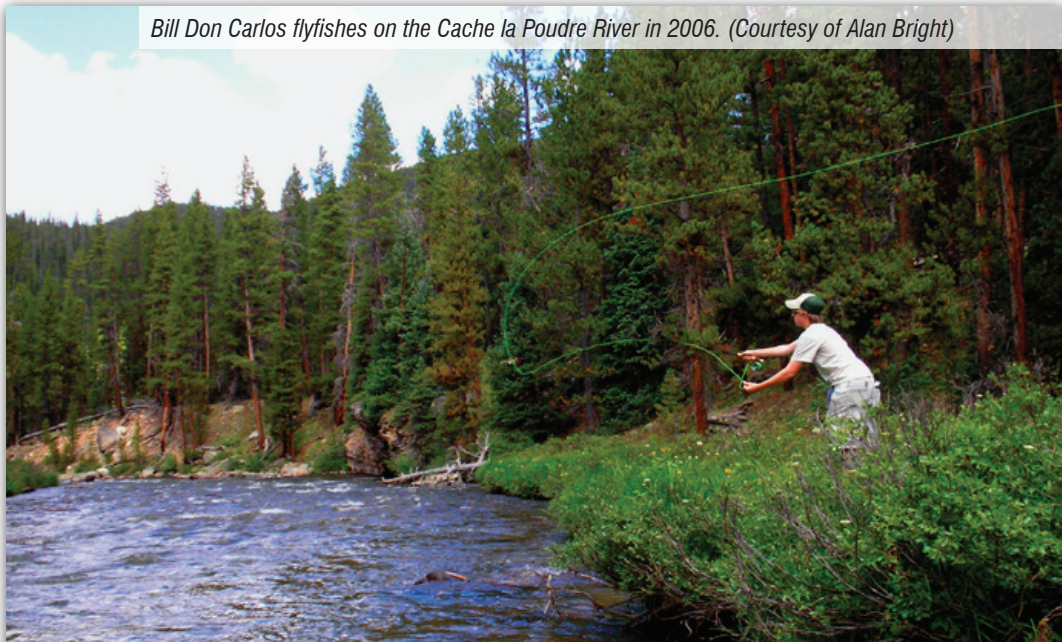
One factor that may explain the ambiguous results of research on the connection between outdoor recreation participation and environmental concern is that these studies focused on a direct relationship between activity participation and environmental concern without considering what the activity means to individuals. Given that the same activity may mean something different for two individuals, it is reasonable to suspect that differences in meaning may explain the ambiguous findings regarding the direct relationship between outdoor recreation and environmental attitudes.

We examined the relationship between outdoor recreation and environmental concern, and the extent to which the meaning of these activities to participants provides a better explanation or prediction of environmental concern than participation. This article describes the results related to those individuals who reported that their most important outdoor recreation activity was fly fishing.

Methods

This study was part of a larger mail survey of hunting and fishing license holders in the state of Washington. Of a total 250 survey respondents, 155 indicated that fly fishing was the most important outdoor recreation activity to them. *Participation* was measured as the anglers' experience use history (the examination of past behavior and experience levels) by estimating how many years they had been fishing and how many times per year. Meaning was defined as anglers' most important *personal motivations* for fly fishing. *Environmental Concern* was measured using The New Ecological Paradigm, a common measure of environmental concern.

Mediation analysis was used to examine the extent to which the meaning of participation in fly fishing mediates the direct relationship between participation and environmental concern. Mediation requires three conditions. In the first condition, the direct correlation between participation in fly fishing (the predictor variable) and environmental concern (the criterion variable) is computed and must exist. In the second condition, a direct correlation between participation in fly fishing and the meaning of the activity (the predictor variable) is computed and must exist. Finally, in the third condition, the correlations between both participation in fly fishing and meaning with environmental concern are computed together. Mediation occurs if, when the meaning of the activity is included in



Bill Don Carlos flyfishes on the Cache la Poudre River in 2006. (Courtesy of Alan Bright)

the computation, the correlation between participation and environmental concern falls to zero (full mediation) or becomes significantly lower (partial mediation).

Results and Discussion

To explore the first condition for mediation, we found participation in fly fishing to be significantly, yet only moderately, correlated with environmental concern. The more often a person went fly fishing, the higher they scored on environmental concern. For the second condition for mediation, participation in fly fishing was most significantly related to *Using Specialized Equipment, Enjoying Nature, and Teaching/Leading Others*. For the third condition (determining if the meaning of activities mediates the direct relationship between participation and environmental concern), environmental concern was regressed on both the meaning of and participation in fly fishing. The positive relationship between participation in fly fishing and environmental concern was fully mediated by the meaning of the activity to participants. That is, what fly fishing means to participants influenced environmental concern, not participation. The extent to which flyfishers participate to enjoy nature and use specialized equipment was positively related to environmental concern, while the importance of teaching others about fly fishing was slightly negatively related to environmental concern.

Using the case of fly fishing, our study supported the notion that one can derive more information about an individual's environmental concern from what an outdoor recreation activity means to him or her, than simply from whether he or she participates in the activity. An important question raised by this study is "what is the real relationship between outdoor recreation participation and environmental concern?" While this study provides interesting insight into what connection may exist between fly fishing (and other outdoor recreation activities) and environmental concern, it is not unreasonable to consider that factors beyond an individual's leisure repertoire impact their environmental concern.

A second question raised is "what is meant by the meaning of outdoor recreation activities?" We used recreation experience preferences as the sole measure of that meaning. It is reasonable to suspect that many other factors might be construed as components of recreation meaning, such as one's socialization into the activity, connection to a specific resource, and social norms related to partners in an outdoor activity.

Much work is needed to better understand the relationship between participation in outdoor recreation and environmental concern. One key issue not addressed by this study is the direction of causality between outdoor recreation participation and meaning and environmental concern. Whether participation in and meaning of outdoor recreation contributes to the development of an environmental ethic, or whether possession of an environmental ethic drives an interest in recreating outdoors is a question requiring more complex experimental designs. It is likely that support for both directions would be found.

Integrating Land and Water Planning: Colorado Learns from Others

by MaryLou Smith, Vice President, Aqua Engineering

The Colorado Department of Natural Resources joined forces with Western States Water Council to stage a September symposium in Denver: "*Water and Land Use Planning for a Sustainable Future: Scaling and Integrating.*" Tony Willardson of Western States Water Council (WSWC)—the water arm of the Western Governors' Association—and Jennifer Gimbel of the Colorado Water Conservation Board (CWCB) each gave their perspectives of why the symposium was important.

For WSWC, the topic of better integration of land use planning with water supply planning is of prime importance to the western governors, as stated in its 2008 report, Water Needs and Strategies for a Sustainable Future, Next Steps. In that report the governors set as a priority that "states should not overtake local planning, but should establish state policies that facilitate the flow of information from water resources agencies to local planning agencies, and that require local governments to create and adopt local comprehensive plans that include a water resources element.

For CWCB, cooperating with Western States Water Council on this issue was seen as an important way to understand how the state of Colorado might address its anticipated water supply gap by integrating water supply planning with land use planning. Members of the Interbasin Compact Committee (IBCC) have keen interest in the topic of how growth might be better managed, perhaps through increased urban density, as a demand side strategy to help meet anticipated water needs for a population expected to double by the year 2050. CWCB is also undertaking a research project to survey stakeholders, catalogue and compare local statutes, and research other states' practices to determine how the state might assist local jurisdictions dealing with these issues.

Representatives from six western states—California, Washington, Oregon, Nevada, New Mexico, and Texas—shared practices they are employing, challenges they are experiencing, and opportunities they see. From the state of Oregon requiring cities to set urban growth boundaries, to California's Urban Water Management Planning Act, to Arizona's Growing Smarter Community planning effort, examples for Colorado to consider were plenty.

Federal agencies, including the EPA, U.S. Fish and Wildlife, U.S. Army Corps of Engineers, and USDA Forest Service, discussed how their agencies are attempting to work more cooperatively with local entities trying to solve complex problems related to water supply and growth. The Corps of Engineers would like to make it easier—not harder—for projects to be permitted by communicating with planners ahead of time to help them consider multiple factors in their plans. The EPA wants to improve water quality by helping communities take more seriously "where to grow."

John Tubbs, the Department of Interior's new deputy assistant secretary for water and science, applauded symposium organizers for tackling a tough subject. He lamented that we have not followed John Wesley Powell's advice that drainage basins should form the primary basis for division of land in the West. Perhaps our task would be easier today had we heeded that advice, he pondered. Tubbs said the first step we should take to reflect the interconnectivity of land use and water supply is "bringing local watershed plans to local land planners."

Colorado governor Bill Ritter shared his administration's vision of a Colorado that "steps up to the plate" to tackle our water challenges. He said Colorado heritage does not include the expectation of instant gratification. Instead, we have a harvest mentality. We expect to work hard and reap the benefits, so we are looking for ways to deal with anticipated growth and climate change. He talked about the need to find ways to promote urban sustainability and water wise development, saying that we can't look at land use planning and water use planning as separate silos, and that in fact, we need to include transportation planning as well. The new energy economy Colorado is undertaking also has repercussions for water, he pointed out.

On the topic of state involvement, Ritter said we need land use planning decisions made at the local level but with consideration of state water policy. With oil and gas rules, we were able to balance the local and the state pretty well. "Perhaps that experience can offer us a good framework for balancing of the local and state in terms of land and water," he said.

Representative Kathleen Curry discussed her House Bill 08-1141, which would require local entities approving new development to take water supplies into consideration. She cited the situation that came up in Pagosa Springs where the city council was offering vested rights to developers to encourage building, without the water and sanitation district knowing how they were going to meet the water need. She said the district sent the city council a letter

Colorado governor Bill Ritter speaks to Western State Water Council attendees about tackling the state's water challenges. (Courtesy of Jacob Bornstein)

informing them about the new law and saying they were supposed to be communicating with one another. "So maybe the legislation has at least been a springboard for communication," she said.

Representative Clair Levy expressed concern that local governments get to make decisions unilaterally about how and where to grow. We don't have any direct legal authority between the state and local jurisdictions on these issues. She said the state hasn't used the power it has because of the local lobby and because the state has not articulated a policy on land use. Levy believes we can deal with growth, congestion, air quality, and future demand for water if we foster more compact development.

Others weighing in on the subject included Chips Barry from Denver Water, Denver Mayor John Hickenlooper, Eric Kuhn from the Colorado River Water Conservation District, Susan Kirkpatrick and Andy Hill from the Colorado Department of Local Affairs, Doug Scott, a developer with Shea Properties, and a trio of non-governmental organizations including Western Resource Advocates, The Sonoran Institute, and C2 Green Development Services.

Grand Junction's utilities director, Greg Trainor, lobbied for the basin roundtables and the IBCC to bring west slope and east slope together to provide for statewide water needs by creating an interbasin compact. Aurora Water's Mark Pifher teamed up with Aurora's mayor Ed Tauer to promote the idea of regional cooperation for infrastructure supply enhancement, because "infrastructure is too expensive to do it on your own." Mark Shively of Douglas County Water Resource Authority asked what we are going to do about growth. "We can demonize it. We can fiddle while Rome burns. Or we can work together to plan water and energy projects," he said.

This symposium was about more than listening to experts. Built in as an integral part of the process was a series of breakout sessions in which participants met in small groups to spend time formulating action ideas. Symposium organizers worked late hours prior to the closing morning to compile and summarize dozens of pages of recommendations that came out of these groups. Jewlya Lynn and Lyn Kathlene from the Center for Systems Integration and CWCB's Jacob Bornstein shared the solution-based themes that emerged from the breakout groups. They said that conferees agreed that those doing land use planning and water supply planning need more information, more communication, more coordination, more integration, and more implementation. Some, but not all, believe we need more regulation. Most believe we need more regionalization.

One group wrote, "Start to better engage and inform, create a better understanding of what is already available, what tools exist. Evaluate and characterize gaps and consequences of actions. From this effort, which can be shared by the state and its many partners—public and private, better legislation can be developed to regulate and manage smarter growth."

Organizers closed the symposium by calling it a kickoff. CWCB and Western States Water Council will be looking for opportunities to build on what we learned, they said. "We will use it as a springboard for further dialogue."

The symposium proceedings and the CWCB research project report will be released in November. To receive notice of the release, contact Rebecca Kahn at the Center for System Integration, rebecca@csi-policy.org

To receive a copy of a detailed report on this symposium, contact MaryLou Smith at mlsmith@aquaengr.com.

The Remnants of an Engineering Feat Still Dangle above the Dolores River: Colorado's Hanging Flume

by Marie Templeton, Historian

Gold—or the desire for gold—has always been an influencing factor on Colorado's history, and so it was on the history of the Hanging Flume on the Dolores River.

In the late 1800s, a major gold strike occurred on Mesa Creek Flats below the confluence of the San Miguel and Dolores Rivers. The Montrose Placer Mining Company, composed of St. Louis capitalists and managed by Col. N.P. Turner, bought six and a half miles of mining claims there. The gold was there, but in what quantities no one was sure. What was sure was that a large supply of water was needed to wash the gold free from the gravel beds. Hydraulic placer mining consists of washing out soil under pressure and catching the gold as it goes over a riffle board through a sluice box. The water was 13 miles away, so it was brought to where it was needed via a remarkable engineering project known as the Hanging Flume.

Using 1.8 million feet of lumber, construction of the wooden flume began below Uravan in 1889. The Montrose Placer Mining Company established a sawmill at Pine Flats, which is above the present Buckeye Reservoir, to cut the lumber for the flume. Only the highest quality lumber was used, consisting primarily of two-inch pine boards. The lumber was hauled by six-horse teams from the sawmill to the construction site, and during one haul the brakes reportedly failed to hold and the runaway wagon ran over and killed the six horses. Another account claims that construction began at the downstream end to allow the lumber to be floated down to the workers.

The hanging flume is a three-sided structure that is open at the top and rests on brackets bolted to the side of the cliff, with the end of the bolt driven 18 inches into the rock. Additional support was provided by a brace extending diagonally down from the outer edge of each bracket to a groove cut into the rock wall. The lower end of each diagonal brace was also anchored to the wall, with a spike driven through the wooden brace and deep into the rock.

The Hanging Flume was constructed along the sandstone cliffs above the Dolores River, which has cut a dramatic canyon in western Colorado. (Photo by Laurie Schmidt)

At one point of the flume, the rock wall projected out and the brackets wouldn't work, so the flume was swung from overhead supports, with metal rods affixed to the outer edge of the flume and anchored into the rock.

According to reports, during the surveying of the flume, the rod man marked the flume line on the sandstone wall from a rope swing called a boson's chair, which was lowered from the top of the cliff. The construction gang of 12 men followed the line marked by red paint and are reported to have erected about 250 feet per day when conditions were good. Their pay was $2.50 per day plus board—good wages in that day. Local labor was used, and surprisingly enough there were no confirmed reports of casualties from working on the flume. In his book *Uncompahgre Country*, Wilson Rockwell tells of one casualty: a man swimming in the Dolores River drowned. Caleb Casebier of Delta wrote, *It is told that one man fell off the flume and plunged to his death in the boulder-strewn river. A lonely grave near the old camp-site may be the resting place of the victim.*

Another account by a Mrs. Peterson reported, *Billy Albrecht, in helping to lower the lumber from the top of the cliff, ventured too close to the edge and slid off. His companions were too terror stricken for a moment even to look down. When at last they summoned the courage to peer over the precipice, they saw Billy. He was sitting precariously on a narrow ledge only a few feet below them in the act of lighting his pipe—to steady his nerves, no doubt.*

What a task it must have been to build the cliff-clinging flume 100–150 feet above the river and 250–500 feet below the summit of the gorge. The flume was built a section at a time, and as it progressed the flume bed served as a roadway on which men and materials could move to the point of construction. A steel scaffold attached to a mine car extended out in space and provided a platform for the driller to stand on while drilling holes in the rock face. The driller's weight was offset by piling boulders in the mine car. After one section was completed, the tracks and the mine car with scaffolding would be moved to the next section and construction would begin in the same manner. Lumber was pulled up from the bottom of the canyon with ropes or lowered down from the top of the canyon, depending on which seemed appropriate.

The flume's caretaker, Charlie Templeton, walked the flume each day during operation to keep it free from trash, which might build up a dam and tear out a section. He had one fringe benefit—a box trap at the end of the flume and an ample supply of mountain trout.

The finished project consisted of four to five miles of ditch and eight miles of flume. It took two years to complete, in 1889-1891, at a cost of $100,000. The flume carried 80 million gallons of water every 24 hours during the time it operated, allowing the placers to work 2,800 cubic yards of gravel per day.

Although the flume itself was a success, the project as a whole was considered a failure and was abandoned in 1893. The gold that inspired this engineering feat was too fine to be recovered under hydraulic pressure, even with the use of quicksilver. The investment was a complete loss, and according to some stories, the promoter of the hanging flume committed suicide after the financial failure (although according to Mrs. Peterson, that is not true). When the flume was abandoned, local ranchers used the lumber for houses, sheds, and other ranch buildings.

Remnants of the Hanging Flume can be seen via a gravel road that runs along the Dolores River between Bedrock and Uravan, CO. (Photo by Laurie Schmidt)

After more than a century, parts of the flume are still visible from Colorado Highway 141 between Gateway and Uravan. Now listed on the National Register of Historic Places, a series of wooden brackets inserted into holes drilled into the cliff face are all that remain today. The wind, rain, sun, and rock slides will eventually take their toll, and in time all evidence of this remarkable enterprise will have vanished. Only the stories will endure.

Dive Right In: Primary Sources for Water-Based Recreation Research in the Water Resources Archive

by Patricia J. Rettig, Head Archivist, Water Resources Archive, Colorado State University Libraries

This 1980 photo shows swimmers at Boulder Beach in Lake Mead National Recreation Area. (From Gilbert Stamm Papers, Water Resources Archive, Colorado State University)

In the arid western U.S., people are drawn to water for recreation, relaxation, and restoration. Fly fishing, kayaking, and skiing are iconic images associated with the western lifestyle. These, as well as opportunities for whitewater rafting, tubing, boating, soaking in mineral springs, and more, attract locals and tourists alike. Even hiking, biking, camping, bird watching, and picnicking often take place along streams or beside reservoirs. Bordered with paved paths, many urban ditches and streams are highly trafficked areas of activity. In these and so many other ways, water is a major component of western recreation.

The Water Resources Archive documents the development and use of western water in all aspects, and water-based recreation is not neglected among its thousands of boxes. Though no single collection focuses solely on the topic, several include materials that provide a good starting point to learn about the evolution of water-based recreation in the West.

With many recreational activities taking place on or near western reservoirs, it is fascinating to discover the total absence of planning for such facilities by the Bureau of Reclamation (Bureau). As Bureau assistant commissioner Gilbert Stamm acknowledged in a speech entitled "Recreation—its place in irrigation development, present and future" at the Tenth Annual Irrigation Operators Conference on February 15, 1961, "In planning and construction of early irrigation projects, recreation was not a problem, nor was it looked on as a benefit. In fact, it was not even considered." (See the speech online at http://hdl.handle.net/10217/27894)

This and other speeches in the Stamm Papers outline not only the Bureau's gradual inclusion of planning for recreation, but also the Bureau's partnerships with other agencies. A 1972 speech celebrates 36 years of partnership with the National Park Service in creating and operating the Lake Mead National Recreation Area, the first program of its kind in the United States. Additionally, photographs and slides in the Stamm Papers capture images of people recreating on and near Bureau reservoirs: swimming, boating, water skiing, picnicking, and more.

Beyond the Stamm Papers, several other collections contain good information related to water-based recreation. These include:

Ival V. Goslin Water Resources Collection

Goslin spent more than 25 years with the Upper Colorado River Commission in Grand Junction and Salt Lake City and later served as the first executive director of the Colorado Water Resources and Power Development Authority. His papers contain speeches on the topic of recreation (see "Recreation and Reclamation" at http://hdl.handle.net/10217/14773), as well as numerous feasibility studies for Colorado water projects. Unlike in the early days of Bureau planning, these studies in the 1980s took recreation into account.

Records of the Colorado Water Resources Research Institute

The CWRRI (now, the CWI) was created in 1965 on the Colorado State University campus to oversee water research and disseminate new information to citizens. The collection contains research on all aspect s of water in the state, including recreational uses. Many of these studies relate to enhancing recreational aspects of water bodies, estimating economic values of water recreation, or the "recreation value" of water.

Records of the Poudre River Trust

The Poudre River Trust is a non-profit organization promoting the revitalization of the Cache la Poudre River, especially those reaches flowing through Fort Collins. The organization has been active in promoting the river's recreational amenities, among other things. Their records document this interest, as well as the river's recreational opportunities.

These collections and others in the Water Resources Archive are a good start at capturing the history of recreational use of water in the West. Consider, however, the limited view that these collections provide. Some forms of water recreation are not documented in the Archive at all, such as hot springs and whitewater rafting. Also, much of this documentation concerns organizations—largely government agencies supplemented by a non-profit organization—rather than businesses or individuals. The Archive does not hold records from rafting companies, fly-fishing outfitters, or avid skiers—but would sure like to.

Future researchers will want to discover how water was used recreationally in the 20th and 21st centuries, and they will want to do this from multiple perspectives and with diverse material types: financial records, diaries, photographs, videos, and more.

The story of water-related recreation cannot be fully told without all perspectives included. If you know of individuals or businesses whose materials could help complete the picture of water-based recreation in Colorado, the Water Resources Archive would appreciate knowing about them.

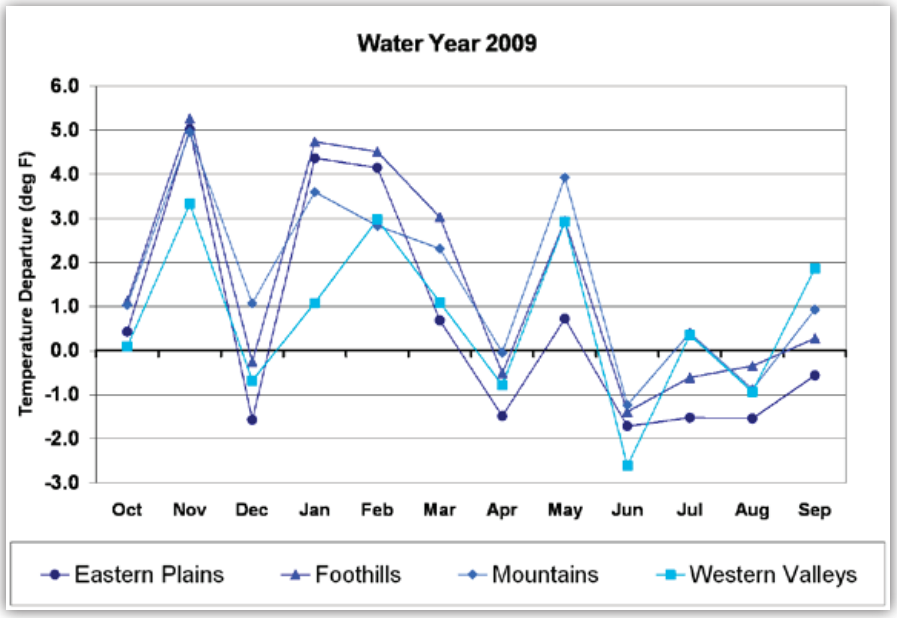
For more information about the collections in the Water Resources Archive, as well as how to donate materials, see the web site (http://lib.colostate.edu/archives/water/) or contact the author (970-491-1939; Patricia.Rettig@ColoState.edu) at any time.

An undated and unidentified photo shows recreators at a Bureau of Reclamation reservoir in the western U.S. (From Gilbert Stamm Papers, Water Resources Archive, Colorado State University)

A Review of the 2009 Colorado Water Year

by Nolan Doesken, Colorado State Climatologist, Colorado Climate Center

The 2009 water year (October 2008–September 2009) is now in the Colorado climate record books. It was a good year for Colorado water. The year began with drought conditions still gripping parts of south-eastern Colorado. A series of October storms crossed eastern Colorado and brought quick relief. Up to four inches of rains soaked parts of the eastern plains, replenishing soil moisture and setting the stage for good winter wheat crops and forage conditions.



November was warm and dry over most of the state, but winter hit hard in December with extremely heavy snows over south-western Colorado and a period of sub-zero temperatures over northeastern Colorado. Over a four-week period, the San Juan Mountains picked up nearly 50% of their annual average precipitation.

The remainder of winter saw a steady progression of mostly small to moderate storms taking aim on the northern and central mountains, while southern Colorado remained dry. A near-average snowpack accumulated, and late winter temperatures were warmer than average for much of the state. Meanwhile, very little moisture spilled over the Continental Divide, leaving the Front Range dry and very windy for much of the winter.

Drought and wildfire concerns increased from Fort Collins and Estes Park southward to Walsenburg and Trinidad as we progressed towards spring. Fortunately, a late March storm—followed by an even larger storm in mid-April—delivered widespread snow and low elevation rains to the Front Range and portions of the plains, largely alleviating the problem and substantially decreasing the need for early season irrigation water for eastern Colorado agriculture.

A series of storms over the desert Southwest brought several major dust storms to western Colorado and deposited layers of dust on the late season snowpack. This raised great concern regarding the potential for a rapid and early snowmelt.

May was two-faced. A mid-month prolonged heat wave led to rapid snowmelt in all of the Colorado Rockies; stream-flows surged and reservoirs filled earlier than usual. Then beginning on May 20, a cool, moist weather pattern set up that persisted through much of June, resulting in above-average precipitation over most of the state and additional high-elevation snow accumulation. It wasn't until late June that it warmed again, resulting in a second snowmelt runoff peak for rivers flowing out of Colorado's northern and central mountains. June brought excessive rains and some damaging hail to parts of northeastern Colorado.

East of the mountains, cooler-than-average summer conditions continued into July and August, with periodic but localized heavy thunderstorms. A surprise late storm on July 20 pounded parts of Denver with large hail, causing several hundred million dollars in reported property damage.

As the water year ended, temperatures returned to near average. The typical flow of moist subtropical air that often brings July-September thunderstorms to the southern and central mountains of Colorado didn't amount to much this summer. As a result, by the end of September, abnormally dry conditions had developed again over the southwest quarter of the state.

Overall, water year precipitation statewide ended up near average, but ranged from below average over portions of southern and western Colorado to above average over several counties in northeastern and east-central Colorado. For example, Burlington received 28.57 inches of precipitation (173% of normal), and Julesburg received 26.84 inches of precipitation (156% of normal) during the 2009 water year, while Boulder received 19.26 inches (97% of normal) and Grand Junction received just 7.94 inches (88% of normal).

Fulbright Scholarship Experience in Zambia, Africa

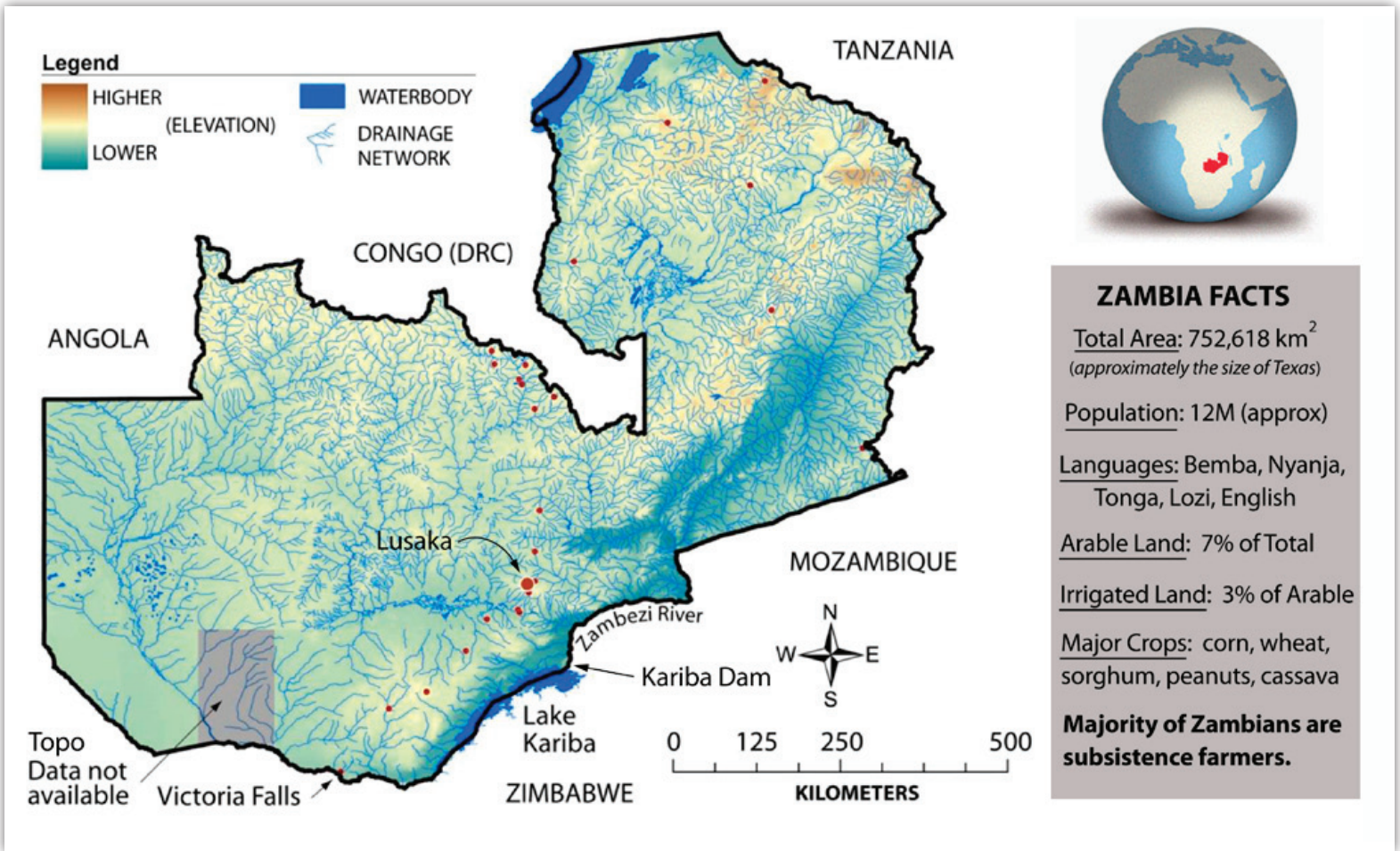
by Perry E. Cabot, Extension Water Resources Specialist, Colorado State University

Introduction

I don't know where the saying originated, but "the trouble with Africa," it goes, "is that it gets in your blood." That statement is even medically accurate in my case, given that I contracted malaria on my recent trip to Zambia. Illness aside, however, I would do it all over again, because what really gets in your blood is the beauty, enormity, and innocence of what has been referred to as this "forgotten continent."

So, on April 20 of this year, my wife Leah and I embarked on the two-day journey that would culminate in our relocation to Lusaka, Zambia, for five months. The main purpose of this trip was for me to teach and conduct research at the University of Zambia (UNZA) under the auspices of the Fulbright Scholarship Program. As the largest city in the country, the capital of Lusaka is intimidating, to say the least. With slightly over three million residents, it is about 15 times more populated than Pueblo, Colorado, where my wife and I live.

We quickly secured housing across the highway from the university that the locals call "Un-Za," and I prepared for my first day of the semester that was scheduled to start April 26. Upon first meeting with my faculty collaborator, Prof. Elijah Phiri in the Department of Soil Science, I was disheartened to learn that the semester had been delayed, and his best guess was that it would be another two months before classes would resume. Such delays were apparently common at UNZA, resulting from a confluence of student strikes, lecturer strikes, and financial obstacles. Be that as it may, my Fulbright schedule was less fluid, so Prof. Phiri inquired as to whether I could prepare an interim series of lectures on Geographic Information Systems (GIS) for their upper-level undergraduates. That was the moment when I recalled the singular advice I had gotten from other Fulbrighters in developing countries. Future Fulbrighters, take heed … ***Be flexible***.



ZAMBIA FACTS

Total Area: 752,618 km^2
(approximately the size of Texas)

Population: 12M (approx)

Languages: Bemba, Nyanja, Tonga, Lozi, English

Arable Land: 7% of Total

Irrigated Land: 3% of Arable

Major Crops: corn, wheat, sorghum, peanuts, cassava

Majority of Zambians are subsistence farmers.

"There Should Not Even Be a Door on Your Office."

I attribute the above quote to a good colleague I made during my stay at UNZA. Prof. Obed Lungu jokingly noted that there seemed to be such a steady stream of students to my office that the door was completely unnecessary. True—I found the students so eager to learn GIS that they seemed disappointed when the lab sessions concluded, and many even pestered me for extracurricular work. Considering that I was already teaching an extracurricular interim session, I found their expanded requests absolutely remarkable. For the next six weeks, it was all I could do to stay ahead of their unquenchable interest.

Hydrology students from UNZA take their first trip to Kariba Dam. Back row (from left): Nkanga Hantambu, Joel Kashinge, Webster Mwale, Dominic Balengu, Chindi Kapembwa. Middle row (from left): Mukuka Mwansa, Kenny Mweemba, John Kachingwe. Front row (from left): Mwilile Simwanza, Prudence Kauzi, Benny Kabwela, Elijah Kabwe, Stanley Haabowa. (Courtesy of Perry Cabot)

Since my original Fulbright proposal included a component related to GIS, I packed several copies of *Getting to Know ArcGIS* published by the Environmental Systems Research Institute (ESRI). Complete with 180-day trial versions of ArcGIS 9.3, these books were invaluable to me as I forged ahead setting up a temporary computer lab using laptops that some of the students were willing to offer up to our cause. For their final class project, I assigned the student teams the task of digitizing David Livingstone's journeys throughout southern Africa between 1840 and 1870. At the suggestion of the department, each of the 32 students who participated in the course was awarded a certificate attesting to their newly acquired skills, which I evaluated through a series of assignments, tests, and individual assessments. In a country where employment is increasingly scarce and opportunities for advancement are minimal, one student remarked as he held the certificate, "Wow. This is going to help me get a job." Understated as it may seem, I couldn't have asked for a kinder validation of my efforts.

Once the semester finally started, I aimed to fulfill my lecturing responsibility to the Fulbright Program by teaching their standard course in agricultural hydraulics and hydrology. This proved to be slightly more difficult than it would seem, given that students at UNZA can barely cover the costs of their own subsistence and tuition, let alone purchase the books and lecture notes that are standard for American students. Needless to say, the man they called "the duplicator" (he who guarded the copy machine) and I became fast friends. As a reward for their hard work, I navigated a maze of bureaucratic permits to take my students on a trip of Kariba Dam, from which Zambia derives the majority of its electricity. Unfortunately, because of power-sharing arrangements with other countries as far away as South Africa, the dam is now operating at its maximum capacity (1320 MW), and load-shedding became a frequent occurrence during the last two months of my stay. Regular blackouts were a stark reminder of the increasing demand for power in a region that is eager to industrialize and achieve the comforts we are afforded in much of the Northern Hemisphere.

Agricultural Advancement in Zambia

I would describe Fulbrighters—in developing countries at least—as the academic equivalent of a "smart bomb." You simply have to get in country first and once there, you target the opportunities where you can have the greatest impact. In accord with this principle, I devoted most of my time to teaching. However, I also wanted to learn as much as possible about Zambian agricultural practices, in hopes that such a knowledge base would lay the groundwork for future collaboration. The most fruitful of my ventures along these lines were the regular trips I made to various agricultural research stations in and around the Lusaka Province, where I was based. Golden Valley Agricultural Research Trust (GART) is as fine an example of a research station as you could expect in the heart of Africa, directed capably by Dr. Stephen Muliokela who oversees all manner of conservation farming, livestock development, and HIV and AIDS mitigation research at the 1300-acre operation.

Aside from certain unfortunate political impediments, Zambian agricultural advancement is hindered by a problem that is strangely familiar to Colorado, except not as one might assume. We might expect that African countries suffer from water shortages, and by and large this fact is true, but not Zambia. Although rainfall varies across the country, annual precipitation rates on the order of 800 mm (31.5 inches) should be a boon to agricultural

Between his teaching schedules, Perry Cabot was able to visit Victoria Falls, taking in this wonder of the natural world from the passenger seat of a microlight aircraft. (Courtesy of Batoka Sky Adventures; Livingstone, Zambia)

development. At commercial scales, even mechanized irrigation is being practiced. Nevertheless, most agricultural operations in Zambia still experience water shortages, just like Colorado. This is because, unlike in our home state, there has been little to no investment in the infrastructure required to store and transport water, even at local scales. With electricity and fuel also at a premium, even pumping from the abundant aquifer situated in the limestone and dolomite layers of the Katanga system is a costly undertaking. Aside from these power constraints, the supply lines of seed, fertilizer, and agri-chemicals are also too unpredictable to allow for stable farming commerce to develop. Consequently, many Zambians are reliant on imported food, despite the abundance of resources surrounding them.

Parting Thoughts

Having little to compare with, aside from my previous experience in Rwanda and the extremes that are broadcast about Africa in the popular media, I can only offer a few generalized observations about Zambia. First, Zambians proudly refer to their country as "the real Africa." Given the abundant macro fauna and stunning landscapes, I would agree with this characterization. I would only add that its "realness" is also reflected in its efforts at modernization, which are becoming more common throughout Africa.

Secondly, I was humbly surprised at the quality of research facilities and laboratories, both on campus and at facilities I visited outside Lusaka. Truth be told, projects move at a slower pace there, but their faculty and staff were engaged in research ventures such as variety trials and drip irrigation, just as you would find at any Land-grant university in the United States.

Finally, I cannot imagine how the students could have demonstrated a greater level of enthusiasm for contact with the world beyond Zambia, even in Lusaka. In my short time there, I had already visited more locations than most of my students combined. In a sense, I would say their eagerness reflected a refreshing trust that many of them felt towards the developed world. Even from their faraway vantage point, they seem to know that their best hopes for the future are still linked to the goodwill of industrialized nations.

Faculty Profile

Joshua Goldstein, Assistant Professor, Dept of Human Dimensions of Natural Resources, CSU

I joined the Department of Human Dimensions of Natural Resources in August 2008, where I am developing a program of research, teaching, and outreach in the field of ecosystem services—the many benefits supplied by nature that support and fulfill our lives. While some of these benefits have well-recognized value in our economy (e.g., food, timber), others have historically had little to no formal market value (e.g., climate regulation). In other words, if we have a score sheet that weighs the costs and benefits of a land use or policy decision, there have been whole categories of value that have been left out of the discussion. The challenge before us is to develop the biophysical, economic, cultural, and institutional knowledge to integrate the full suite of ecosystem services into decision making to better manage our planet's natural capital, today and into the future. Hydrologic ecosystem services, such as provision of water for human consumption and agriculture, mitigation of flood risk, and water pollution regulation, are an integral component of this new field.

The ecosystem services framework helps us better understand the direct linkages between the environment and human well-being. Ecosystem services are more than just luxury goods that society should protect once it is sufficiently affluent—they make us realize that humans depend directly upon nature to support our lives. My formal training in ecosystem services began at Stanford University, where I obtained my Ph.D. in environment and resources in 2007. I then continued with a one-year post-doctoral fellowship with the Natural Capital Project, a partnership between Stanford University, The Nature Conservancy, and World Wildlife Fund, whose mission is to align economic forces with conservation by mainstreaming natural capital into decisions. All of my educational experiences to date have played an integral role in shaping my passion for working in interdisciplinary teams and for working closely with partners outside the university, both of which I see as being critical to solving today's complex problems at the human-environment interface.

Research

My research addresses the question of how to strategically invest in conserving biodiversity and supplying ecosystem services across public-private landscapes. My work combines ecological and economic approaches to examine this question from the perspectives of private landowners and corporations, as well as groups investing in conservation (e.g., public agencies, conservation NGOs). For the past five years, I have been developing a research program in Hawai`i with academics, landowners, public agencies, conservation groups, and other partners. I am now exploring new projects in Colorado and Panama.

My research interests fall into four general categories. First, I am exploring strategies to create diversified business models for private landowners that incorporate income from ecosystem-service values to deliver conservation and production benefits from working agricultural lands. Second, I am using a return-on-investment framework to determine which investments in biodiversity and ecosystem services provide the greatest conservation "return" per dollar invested. Third, I am working in collaborative groups to explore ways to design payment programs for ecosystem services to achieve environmental targets, while also supporting community livelihoods. Fourth, I am working with partners from the Natural Capital Project to advance the integration of ecosystem services into land use planning and policy decisions, working specifically with partners in Hawai`i.

Teaching

During spring semester 2009, I developed two new courses on ecosystem services taught through the Warner College of Natural Resources: NR 381A1 (undergraduate) and NR 580A3 (graduate). These courses exposed students to the integrated biophysical, economic, and institutional theory of ecosystem services, as well as how these concepts are being applied through innovative projects across the world, from Colorado to South Africa to China and beyond. I will be offering these courses again this spring, and I am looking forward to developing follow-up courses that give students the opportunity to work with ranchers, public agencies, and other groups in the local area to put their knowledge of ecosystem services into action. My other teaching role is helping to launch a new master's initiative called Conservation Leadership Through Learning (CLTL). The goal of CLTL is to train the next generation of conservation leaders who have the scientific, leadership, and management skills to diagnose environmental problems from a systems perspective and to catalyze more holistic and effective solutions for the environment and people's livelihoods. For more information, please visit: http://leadershipthroughlearning.org.

Although I am now in my second year at CSU, I am still getting to know people. I look forward to meeting you and exploring opportunities for collaboration.

Joshua H. Goldstein, Ph.D.
Assistant Professor

Colorado State University

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Water Quality and Stormwater Issues
for Ditch Companies

CLE Credit Applied for! (1.5 Hours)

When: Friday, January 8, 2010
1 p.m. to 5 p.m.
Where: ATLAS Institute (Alliance for Technology, Learning, and Society)
Room 229
The University of Colorado
Boulder, Colorado
(at the corner of 18th and Colorado on Campus)
Cost: $50 for DARCA/CWC members;
$100 for non-members

Urbanization has been occurring along ditches and their riparian corridors since Colorado's first ditches were built in latter half of the 19th century and this urban growth has placed many pressures on Colorado ditch and reservoir companies. One issue that is increasingly becoming more prominent is the impact of stormwater - both in terms of quaility and quantity - into these ditches. The workshop will help participants identify and frame these issues and develop appropriate solutions to eliminate or mitigate potential damage and liability to their ditch systems.

The workshop will begin with an informative presentation about the work that is being done to protect water quality in the Boulder Creek and St. Vrain watersheds from urban runoff. Janice Lopitz, the project coordinator of the Keep it Clean Partnership, will describe the state mandated stormwater programs being implemented to address urban runoff from the residential, commericial and construction communities.

Next, Richard Belt, P.E., P.H. of Aqua Engineering will discuss the many stormwater engineering topics including the use of case studies from local ditch companies. Richard's presentation will focus on:

- **Basic Hydrology** of pre and post-development scenarios in the context of water quantity and quality addressing tributary and distributary systems.
- **Quantity Management Issues** and how to lessen post-development impacts through appropriate basin and outlet designs.
- **Quality Management Issues** for inflows into ditches incluing concentrated and sheet flow techniques and primary contaminants of concern.
- **Effectively Interacting with Cities, Counties and Other Agencies** What are typical development standards and what does a typical post-development for a ditch system really look like.
- **FEMA and Floodplain Management** The management of flood-plains by FEMA and the impact on ditch companies

The workshop will conclude by John A. Akolt, Esq. who will address water quality and stormwater issues that impact ditch and reservoir companies in Colorado. John, counsel for Farmer's Reservoir and Irrigation Company in Brighton, has extensive experience in dealing with water quality and stormwater issues in Colorado and he will be able to discuss optimal legal strategies.

DARCA's Water Quality for Ditch Companies workshop is sponsored by Applegate Group Inc., URS Corporation, and Aqua Engineering Inc..

Register online at www.darca.org

Water Research Awards

Colorado State University (August 15 to October 15, 2009)

Arabi, Mazdak, Civil and Environmental Engineering , USDA Cooperative State Research Education & Extension Service, A Multi Criteria Decision Tool for the Assessment and Planning of Watershed Management Practices, $615,000

Bagley, Calvin F, CEMML, U.S. Army Corps of Engineers, Watershed Basin Survey, Analysis and Modeling at Fort Richardson, Alaska, $237,940

Bauder, Troy A, Soil and Crop Sciences, Colorado Department of Agriculture, Training and Education for Agricultural Chemicals and Groundwater Protection, $185,000

Bauerle, William L, Horticulture and Landscape Architecture, USDA Agricultural Research Service, Measurement and Modeling Plant Water Use to Quantify Nursery Water Requirements, $48,780

Bestgen, Kevin R, Fish, Wildlife and Conservation Biology, U.S. Bureau of Reclamation, Demographic Estimates and Monitoring for Razorback Sucker in the Colorado and Green River Basins, Utah & Colorado, $83,603

Caspari, Horst W, Western Colorado Research Center, Colorado Department of Agriculture, Viticulture and Enology Programs for the Colorado Wine Industry, $194,114

Cooper, David Jonathan, Forest Rangeland Watershed Stewardship, U.S. Army Corps of Engineers, What Is A Hydrophyte? How Conifers, Herbaceous Dicots and Bryophytes Grow in Upland and Wetland Environments, $81,856

Cooper, David Jonathan, Forest Rangeland Watershed Stewardship, Yellowstone Park Foundation, Vanishing Wetlands of Yellowstone National Park's Northern Range: Watershed, Hydrology, Soils and Vegetation, $50,070

Cooper, David Jonathan, Forest Rangeland Watershed Stewardship, USDA-USFS-Rocky Mountain Research Station- Colorado, Water and Carbon Storage in Peatlands of the Rocky Mountains: Ecosystem Indicators of Climate Change, $122,000

Doesken, Nolan J, Atmospheric Science, U.S. Bureau of Reclamation, Walking Through the Water Year, $40,000

Fausch, Kurt D, Cooperative Fish and Wildlife Research, Colorado Division of Wildlife, Plains Fish Translocation Success, $30,000

Fausch, Kurt D, Fish, Wildlife and Conservation Biology, Wyoming Game & Fish Department, Climate Change Tool for Cutthroat, $58,677

Homann, Richard L, Colorado State Forest Service, USDA-USFS-Forest Research, ARRA: High-Priority Forest Rest/Fuels Mitigation, $6,250,010

Johnson, Brett Michael, Fish, Wildlife and Conservation Biology, National Park Service, Evaluate Lake Trout Suppression Strategies for Blue Mesa Reservoir, $10,000

Johnson, Brett Michael, Cooperative Fish and Wildlife Research, Colorado Division of Wildlife, Evaluate Lake Trout Suppression Strategies for Blue Mesa Reservoir, $141,000

Julien, Pierre Y, Civil and Environmental Engineering, U.S. Bureau of Reclamation, Sediment Modeling Analysis Support, $72,000

Kampf, Stephanie K, Forest Rangeland Watershed Stewardship, U.S. Department of Energy, Climate Change Impacts to Hydropower Generation in Pacific Northwest River Basins, $130,392

Khosla, Rajiv, Soil and Crop Sciences, USDA Natural Resources Conservation Service, Innovative Active Remote Sensing and Site-Specific Management Zones for Enhancing Nutrient Use Efficiency and Water Quality, $74,847

Kumar, Sunil, Natural Resource Ecology Laboratory, U.S. Geological Survey, A Modeling System for Invasive Species, $99,348

Kummerow, Christian D, Atmospheric Science, NASA, The Next Generation Rainfall Retrieval Algorithm for Use by TRMM and GPM, $84,000

Labadie, John W, Civil and Environmental Engineering, Colorado Springs Utilities, Efficiency and Performance Improvement of Colorado Springs Utilities MODSIM Daily Model for Water Supply Yield Analysis, $34,239

Lee, Brook L, Colorado State Forest Service, USDA-USFS-Rocky Mountain Research Station - Colorado, Effects of Mountain Pine Beetle and Forest Management on Water Quantity, State Forest, $50,694

Lemly, Joanna, Fish, Wildlife and Conservation Biology, Colorado Division of Wildlife, Statewide Wetland Strategies, $78,092

Lemly, Joanna, Fish, Wildlife and Conservation Biology, USDA-USFS-Forest Research, Wetland Condition Assessment on the Rio Grande National Forest, $28,366

Loftis, Jim C, Civil and Environmental Engineering, National Park Service, Status and Trends of Impaired, Threatened, and Outstanding National/State Resource Waters, $232,101

Lyon, Margarette J, Fish, Wildlife and Conservation Biology, USDA-USFS-Forest Research, White River National Forest Fen Inventory, $15,026

Neupauer, Roseanna, Colorado Water Institute, U.S. Geological Survey, Adjoint Modeling to Quantify Stream Flow Changes Due to Aquifer Pumping, $117,847

Paschke, Mark W, Forest Rangeland Watershed Stewardship, National Park Service, Year 2 & 3 - Restoration of Native Plant Communities Following Saltcedar and Russian Olive Removal, $107,421

Qian, Yaling, Horticulture and Landscape Architecture, Denver Water Department, Soil Testing Five Years after Irrigation with Recycled Water, $38,949

Ramirez, Jorge A, Civil and Environmental Engineering, U.S. Army Research Office, Quantifying the Complex Hydrologic Response of Anephemeral Desert Wash, $65,000

Sanders, Thomas G, Civil and Environmental Engineering, National Park Service, Mod 1: Integration of NPS/USGS Water Resources Science Applicable to Management of Protected Areas, $142,537

Stednick, John D, Forest Rangeland Watershed Stewardship, USDA-USFS-Rocky Mountain Research Station - Colorado, Determining Water Chemistry and Flow from GLEES Catchments, $12,000

Theobald, David M, Human Dimensions of Natural Resources, USDA-USFS-Rocky Mountain Research Station - Colorado, Assessment of Watershed Condition in Colorado with Implications for Fuels Management, $50,000

Valliant, James C, Arkansas Valley Research Center, Lower Arkansas Valley Water Conservancy District, The Effect on Corn Yield, Nutrient Needs and Economics when Fallowing Land in the Arkansas River Valley, $10,020

Wohl, Ellen E, Geosciences, USDA-USFS-Forest Research, Environmental Flow Strategy Validation Project, $45,000

Wohl, Ellen E, Geosciences, USDA-USFS-Forest Research, White River Analysis, $75,000

University of Colorado (May 1 to October 15, 2009)

Anderson, S, INSTAAR, National Science Foundation, EAR-PF: Critical Zone Controls on Hydrology and the Fate of Nitrogen in Montane Forests of the Colorado Front Range, $6,000

Averyt, K, CIRES, Agriculture Forest, Integrated Needs Assessment for the Western Watersheds and Climate Change: Water and Aquatic System Tools Workshop, $7,941

Gin, Do, Chemical Engineering, National Science Foundation, Study and Development of a New Type of Water Nanofiltration Membrane with an Ordered, Sub-one-nanometer Size Pore System, $280,000

Jimenez, J, CIRES, National Science Foundation, Collaborative Research: ETBC--Exploring Forest Ecosystem Response to Water Availability and the Impact on Biogeochemical and Water Cycles, $1,000,000

Kenney, D, Natural Resources Law Center, Colorado State University, Assessing the Relative Costs/ Values of New Water Supply Options, $35,000

Oakes, T, Geography, National Science Foundation, Water Resources Development and National Identity Building in Northwestern China, $12,000

Perkins, T, JILA, National Science Foundation, MRI: Development of an Atomic Force Microscope with Atomic Scale Stability for Biological Studies in Water, $598,383

Pierpont, C, Chemistry, NREL, Development of an Economical Electrocatalyst for Water Oxidation, $100,000

Rosario-Ortiz, F, Civil Engineering, City of Longmont, Emerging Contaminants in the Longmont Watershed, $67,649

Rosario-Ortiz, F, Civil Engineering, National Science Foundation, BRIGE: Reactivity of Effluent Organic Matter (EfOM) towards Hydroxyl Radical and Its Effect on the Application of Advanced Oxidation for Water Reuse Applications, $174,977

Steffen, K, CIRES, NOAA, Western Water Assessment 2009-2010 - Task III, $13,626

Tierney, K, Institute of Behavioral Science, Deltares, Netherlands/ US Water Crisis Research Network (NUWCREN), $236,703

White, J, INSTAAR, National Park Service, Inventory of Sierra Nevada Network Stream Flow and Snow Water Equivalent, $59,999

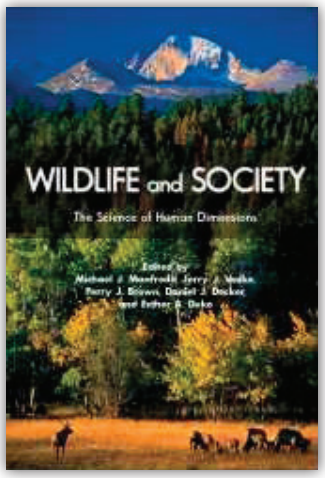
Williams, M, INSTAAR, National Park Service, Rocky Mountain Inventory and Monitoring Network Stream Ecological Integrity Monitoring, Water Chemistry Project, $4,202

Zagona, E, Civil Engineering CADSWES, Bureau of Reclamation, Stochastic Streamflow Simulation at Interannual and Interdecadal Time Scales and Implications to Water Resources Management in the Colorado River Basin, $253,000

Zagona, E, Civil Engineering CADSWES, The Nature Conservancy, Modeling the Reliability of Environmental Flows under Changing Water Availability and Demands at the Basin Scale and under Integrated Water Resources Management in the Colorado River Basin, $36,161

CSU Faculty Receive Wildlife Society Book of the Year Award

A book co-authored by three CSU faculty members in the Department of Human Dimensions of Natural Resources is the 2009 recipient of The Wildlife Society's Wildlife Publication Award. The book, titled *Wildlife and Society: The Science of Human Dimensions*, was recognized in the outstanding edited book category. The authors were acknowledged in September at the Wildlife Society's 16th Annual Conference in Monterey, California.



The book addresses a growing area of study known as the human dimensions of fish and wildlife management. The field of study includes issues such as understanding public demands for wildlife recreation, managing conflict among competing wildlife interests, educating the public about wildlife, ensuring the safety of people who encounter wildlife, and controlling poaching while helping create sustainable subsistence hunting.

"During most of the 20th century, biology informed sound wildlife management decisions. Increasingly, however, it is recognized that managing wildlife means managing people. That is where the social sciences can provide help," said Michael J. Manfredo, head of the Department of Human Dimensions of Natural Resources and of the Department of Forest, Rangeland and Watershed Stewardship at CSU. "The problems of wildlife management almost always involve the behavior of humans." Manfredo co-authored the book with Jerry J. Vaske and Esther A. Duke, also of CSU's Department of Human Dimensions of Natural Resources; Perry J. Brown of the University of Montana; and Daniel J. Decker of Cornell University.

Wildlife and Society: The Science of Human Dimensions offers perspectives branching from a variety of academic disciplines and presents views of professionals from the United States, Europe, Africa, and Latin America. These distinctive elements make the book an important new reference for professionals and community members concerned with environmental conservation and fish and wildlife management. The book was recently translated and released in Japan.

**This article was adapted from a September 22, 2009, CSU news release.*

CSU's New Dean of College of Agricultural Sciences

Craig Beyrouty

I am delighted to have joined the College of Agricultural Sciences as dean this July. Before coming to CSU, I served as head of the Agronomy Department at Purdue University, one of the larger departments within the College of Agriculture. My experiences and responsibilities there are ones that will serve the College well, because I believe certain qualities of respected land-grant universities are universal. For example, fostering relations with our clientele is crucial to the College of Agricultural Sciences. Whenever possible, I encourage industry groups, from the Colorado Cattlemen's Association to Monsanto to the Apple Administrative Committee, to maintain an active dialogue with the College to address the needs of Colorado farmers and residents alike.

The College is highly regarded throughout the nation; faculty are recognized leaders in their disciplines, and creative strategies have helped increase and diversify undergraduate and graduate student populations and enhance the impact from the educational and research programs. The strategic plan offers me an opportunity to communicate that the citizens of Colorado remain the primary focus of the College.

Within the College itself, I believe diversity strengthens our disciplines and leads to creative approaches to problem solving; thus, diversity must be a College priority. In addition, the curriculum is the hallmark of a university and is the reason we exist as institutions of higher learning. We have a responsibility to develop talented and creative thinkers who

can adapt to a changing world and who can apply their knowledge to unfamiliar situations.

The citizens of Colorado look to the College of Agricultural Sciences to energize the state's economy and to position Colorado to be competitive globally. I am excited to provide leadership at an institution where the land-grant mission is valued and collaboration and innovation are central to execution of that mission.

We've heard a lot lately about the great challenges we face, both locally and globally, from economics to issues of water availability and the world food system. I've been very sensitized to many of the water-related issues in Colorado and surrounding states, such as our ability to continue producing agricultural products while balancing municipal and industrial needs with limited water resources. Agriculture plays a central role in developing management practices and technologies that help ensure that there is enough water to produce the food we need and allow people to enjoy living in Colorado. My goal will be to assemble the appropriate expertise and resources in the College of Agricultural Sciences that ensure the sustainability of this valuable resource.

Craig Beyrouty, Ph.D.
Dean

Colorado State University

Dean of Agricultural Sciences
Colorado State University

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Calendar

December

1 **Best Management Practices for Ditch Companies; Longmont, Colorado**
Address the issues that ditch companies face in dealing with their urban neighbors.
http://www.darca.org/content/view/217/89/

10-13 **2009 NGWA Ground Water Expo; New Orleans, Louisiana**
Groundwater professionals explore new solutions to today's challenges.
http://www.ngwa.org/2009expo/index.aspx

January

8 **Stormwater and Water Quality for Ditch Companies; Boulder, Colorado**
Develop appropriate solutions to eliminate or mitigate potential damage to ditch systems.
http://www.darca.org/content/view/218/89/

27 **Directors and Officers Training for Ditch Companies; Denver, Colorado**
DARCA's team of experts will discuss Corporate governance basics for ditch companies.
http://www.darca.org/content/view/215/89/

27-29 **Colorado Water Congress Annual Convention; Denver, Colorado**
The annual premier event of the Colorado Water Congress.
http://www.cowatercongress.org

February

10 **Micro Hydroelectric Opportunities for Dam Owners and Operators; Durango, Colorado**
Pre-convention workshop before the 8th Annual DARCA Convention.
http://www.darca.org/content/view/219/89/

10-12 **8th Annual DARCA Convention; Durango, Colorado**
Issues relevant to Colorado's water providers in the context of agriculture.
http://www.darca.org/content/view/160/81/

21-24 **Utility Management Conference; San Francisco, California**
Water and wastewater professionals discuss all aspects of utility management.
http://www.awwa.org/index.cfm

March

7-9 **2010 WateReuse California Annual Conference; San Diego, California**
Discuss the design, management, operation, and use of water recycling facilities.
http://www.watereuse.org

9 **Augmentation for Ditch Companies; Denver, Colorado**
This workshop will encompass all phases of augmentation.
http://www.darca.org/content/view/221/89/

15-18 **20th Annual AEHS Meeting & International Conference; San Diego, California**
Environmental professionals gather to discuss soils, sediments, water, and energy.
http://www.aehs.com/conferences/westcoast/overview.htm

22-24 **Hydrology Days; Fort Collins, Colorado**
The 30th Annual Hydrology Days, held on the Colorado State University campus.
http://hydrologydays.colostate.edu

23-26 **USCID Water Management Conference; Sacramento, California**
Theme is "Upgrading Technology and Infrastructure in a Finance-Challenged Economy."
http://www.uscid.org/10idconf.html

29-31 **2010 AWRA Spring Specialty Conference; Orlando, Florida**
The AWRA's biennial survey of the state of knowledge in GIS and water resources.
http://www.awra.org

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http://www.cwi.colostate.edu

CSU Water Center
http://www.watercenter.colostate.edu

Rafters navigate the whitewater in Gore Canyon on the Colorado River. (Courtesy of www.ColoradoRafting.net)