COLORADO WATER

Newsletter of the Water Center at Colorado State University

APRIL 2002

NEW WATER ARCHIVE WILL PRESERVE COLORADO'S WATER HERITAGE

CSU's faculty played key role . . .

Archivists spent more than 1,000 hours indexing materials that span most of 20th century.

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WATER ITEMS AND ISSUES . .

Preserving Colorado's Water History — *Editorial by Robert C. Ward, Director* 3
Water Archive Opens at Colorado State University 4
Second USDA Grant Will Provide Funding for 3 Additional Students 6
RESEARCH – The Identification, Historical Distribution, and Habitat Requirements of Brassy Minnow in Colorado Plains Streams 8
WATER SUPPLY 11
CSU AGRICULTURAL EXPERIMENT STATION
Development of a Manure Sampling Protocol and a Mountain West Manure Database 12
CSU COOPERATIVE EXTENSION
Assessing Colorado Ground Water Quality and Vulnerability 16
MEETING BRIEFS
- **Funding Challenges Face Water Institute Directors At Annual Meeting** 20
- **Economics of the Ogallala: 2002 Ogallala Symposium Held in Sterling** 22

New Faculty Profile 25
CU Water News 26
CSM Water News 27
UNC Water News 28
Research Awards 29
Publications 32
Water News Digest 33
Meetings 38
Calendar 39

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EDITORIAL

PRESERVING COLORADO'S WATER HISTORY

Editorial by Robert C. Ward, Director

Water is allocated to beneficial uses in Colorado via the *prior* appropriation doctrine. The very name of the doctrine implies that we know and understand the history of water allocation in the administration of today's water rights. When there are disagreements over water allocation and administration, it often results in an historical search of a particular area's original water allocations and use patterns over time. Thus, preserving and protecting the history of water resources development and use in Colorado is critical to the proper functioning of Colorado's water allocation system.

Furthermore, over the years a large number of individuals and organizations have been actively involved in water management in Colorado, including institutions of higher education. Their contributions to Colorado's rich and long water history are documented in papers that often are not well protected or preserved.

Colorado State University has recognized the need to protect and preserve Colorado's water history, and also the need to promote and explain that history to Colorado citizens. On February 7, 2002, CSU formally announced the creation of a new Water Resources Archive in the university's Morgan Library. On page 4 of this issue is an article that describes the new archive, its current contents, and plans for its future. I am extremely pleased to see CSU step forward and assume a major role in preserving the contributions of many individuals and organizations as well as preserving data so critical to understanding past water allocations. As Colorado's water management system evolves to meet ever changing water needs, the history contained in the new archive will become even more valuable.

Regarding Colorado's history of water resources, the state is celebrating the sesquicentennial of its earliest priority water right on April 10, 2002. The first water right in Colorado, dated April 10, 1852 and issued for the San Luis Peoples Ditch in the San Luis Valley, provides 23 cubic feet per second for irrigating 900 acres. I was reminded of the sesquicentennial quite by accident when I came across the proceedings of the 100-year celebration of the water right in the CWRRI library. On April 8 and 9, 1952, Adams State College hosted a meeting consisting of presentations by key water leaders of the day. On April 10, 1952, the meeting shifted to San Luis, Colorado, where a parade preceded dedication of a monument, constructed by Delfino Salazar on the banks of the Peoples Ditch, containing a bronze memorial furnished by the State Historical Society. The attendees that day included retired CSU President Charles Lory, then current CSU President William Morgan, Ralph Parshall, and M.C. Hinderlider among many other Colorado water leaders. The proceedings of the celebration are available for reading on the CWRRI web site at http://cwrri.colostate.edu/.

The current issue of *Colorado Water* is a vivid reminder that Colorado's water history is still being written. Articles in this newsletter, for example, review key issues discussed during the Ogallala Symposium, held February 21, 2002; report on water level changes in the Ogallala aquifer in Colorado; characterize the life cycle of the Brassy Minnow in the Arikaree River; and describe an effort to develop a statewide overview of ground water quality in Colorado. Each of these articles reflects the importance of obtaining new information about Colorado's water resources – i.e., collecting new data, undertaking new research studies, and developing new ways to present water information. The value of water research to improved water management, in the opinion of this obviously biased writer, cannot be over emphasized. The High Plains-related articles demonstrate clearly that while we must protect our water history, we also must continue to advance our understanding of Colorado's water resources with new knowledge – knowledge that assists Colorado's water users and managers in operating a state-of-the-art water management system carefully constructed on the lessons of the past.

WATER ARCHIVE OPENS AT COLORADO STATE UNIVERSITY

Colorado State University's rich and long-standing tradition of water research, education and service is now complemented by the creation of a new Water Resources Archive. Located in new archive facilities in the remodeled Morgan Library, the Water Resources Archive will preserve, protect and promote the history of Colorado water through the papers, maps, and records of significant figures such as Ival G. Goslin, Whitney Borland, Robert Glover, J.R. Barkley and James L. Ogilvie, whose collections inaugurate the Archive. "The University Libraries is thrilled to be home to this rich collection of primary water resource materials," said Julie Wessling, Interim Dean, University Libraries.

The collection includes the papers of: J.R. 'Bob' Barkley, outlining his participation in the National Water Reclamation Association from 1934-1969 (the National Water Resources Association today); the Rocky Mountain Hydraulics Research Station near Allenspark, Colorado; and the Colorado Water Resources Research Institute. The Archive also houses the Ival Goslin Collection, which consists of a complete set of the technical data and reports generated by the Colorado Water Resources and Power Development Authority during the 1980s. The Goslin Collection documents Colorado's continued water project planning despite President Carter's late 1970s removal of the Federal government from such planning. The papers of Whitney Borland, Robert Glover and James L. Ogilvie describe the careers of prominent water engineers involved in a number of Bureau of Reclamation projects and other water developments from the 1930s until the 1980s.

> ***As current and future Colorado citizens face increasingly complex water policy and management challenges, it is critical that we understand how and why Colorado and the West established their current water management policies and institutions. The new archive provides this store of water knowledge, which is so critical to sound future water policy development . . .***
>
> **Robert Ward, Director, Colorado Water Resources Research Institute (CWRRI).**

The Archive represents a partnership of the Colorado Water Resources Research Institute (CWRRI), the Colorado Agriculture Archive, and CSU Libraries to sustain important collections that document individual and organizational efforts that have influenced the availability of today's water resources. "As current and future Colorado citizens face increasingly complex water policy and management challenges, it is critical that we understand how and why Colorado and the West established their current water management policies and institutions. The new archive provides this store of water knowledge, which is so critical to sound future water policy development," said Robert Ward, Director of the Colorado Water Resources Research Institute (CWRRI).

Professor John Newman, Colorado State University Archivist, is directing the creation and operation of the new water archive. As collections are received, CSU staff organize the materials, properly store them, and develop guides to collections. The University Archives staff provides a world class-service to archive users so this rich history can be tapped in an environment that respects the historical importance of the materials.

According to Newman, "These are large collections, measured physically in hundreds of feet and tens of tons. Their value for research and current policy is more difficult to measure, but clearly much greater. Virtually every document is one-of-a-kind. At CSU, we have excellent collaboration between indexers and water scholars. The Water Resources Archive benefits from the talents of both groups."

To make collections more accessible, a comprehensive web site is planned for the near future that will provide a gateway to the collections, including virtual exhibits of selected items from the collections. "The web presence will attract a wider range of researchers to explore the technical, environmental, cultural and societal perspectives on water in Colorado and the western United States represented

in the rich and unique holdings of the Archive," said Newman.

Papers critical to the water history of Colorado and the West are widely dispersed. The CSU Water Resources archivists, besides organizing historical, water-related documents currently located on campus, will compile a list of critical water collections located in Colorado.

Dr. Ward explains that the Water Resources Archive is the result of several years of planning and organization. "Colorado State University has an extremely rich tradition in water education, research and outreach, both within Colorado and around the world," he says. "The archive allows CSU to preserve, protect and promote not only its own water traditions and heritage, but also those of Colorado, the Western U.S., and water organizations and leaders around the world. More than 100 CSU faculty apply their disciplines to water and water-related topics, and this facility will greatly expand the ability of CSU scholars, as well as other scholars, to access the rich water history of Colorado, the West and the world. The archive will also provide Colorado water users and managers access to Colorado's water history, especially as that history frames Colorado's water future. In a state where '*prior* appropriation' (emphasis added) is the guiding doctrine for water management, history is important. I am very pleased that CSU is preserving and protecting this valuable history."

> ***The archive allows CSU to preserve, protect and promote not only its own water traditions and heritage, but also those of Colorado, the Western U.S., and water organizations and leaders around the world.***
>
> **Robert Ward, Director, Colorado Water Resources Research Institute (CWRRI).**

Persons interested in this collection should call or write ahead, as far in advance as possible, to discuss their research projects and to arrange times for access and assistance that are mutually agreeable. This will allow staff time to assemble the necessary material and finding aids. If appropriate, descriptive documents can be copied and sent to a researcher prior to the visit.

For more information about the CSU Water Resources Archive, contact Robert Ward at cwrri@colostate.edu or phone 970/491-6308.

NGOS WELCOME EUROPEAN PARLIAMENT'S CLEAR "NO" TO WATER TRANSFERS

Press Release - 28 February 2002

Brussels - Environmental nongovernment organizations WWF, BirdLife International and the European Environmental Bureau (EEB) welcome the clear position taken by the European Parliament against unsustainable water management schemes across Europe. European Parliamentarians adopted a tough Resolution on the "European Union's Sustainable Development Strategy." The Resolution contains a clear expression of concern about "the precedent set by proposals for the development of unsustainable water management schemes across Europe" such as water transfers, and calls on the Commission to "not provide any EU funding for such water transfer projects." Members of the European Parliament stopped short of issuing an outright condemnation of the Spanish Hydrological Plan law of 20 June 2001 by removing a specific reference to it that had been voted at last weeks' Parliamentary Committee on the Environment. Nonetheless, NGOs hope that the Parliament's Resolution will send a clear signal to decision-makers in Madrid and in the rest of the EU that this type of water management scheme is viewed as unsustainable by many across Europe. The Spanish Hydrological Plan is a "water transfer" law, including as many as 863 water infrastructure works and other developments including dams and reservoirs - on top of the piping for the transfers. NGOs believe that the plan could lead to the destruction of many areas requiring protection under EU nature conservation, such as the Ebro Delta. They estimate that as many as 86 Special Protection Areas and 82 Sites of Community Interest, as designated under the Wild Birds and Habitats Directives are under threat from the infrastructure development required by the plan. Moreover, they state that the plan will contravene the principles of sustainable water management by substantially increasing water demand in Spain and clearly violating the legal provisions of the EU Water Framework Directive. Worse still, say NGOs, the plans are likely to be part-financed by the European taxpayer. It is understood that the Spanish authorities are looking for a seven billion Euro cash injection for the scheme from the EU's cohesion and structural funds.

SECOND USDA GRANT WILL PROVIDE FUNDING FOR THREE ADDITIONAL STUDENTS

A second USDA grant to Colorado State University will provide funding for three additional fellows to conduct research on water management issues critical to Colorado agriculture in the Western United States. The Cooperative State Research, Education, and Extension Service (CSREES) awarded the $207,000 grant to Jim Loftis, Civil Engineering Department, CSU and Jessica Davis, Soil and Crop Sciences Department, CSU in February 2002. The doctoral fellowships carry a stipend of $22,000 per year for three years plus a travel allowance to attend two national technical conferences.

The first grant by CSREES was made in early 2000, and fellows selected for the program were Garey Fox, pursuing his Doctorate in Civil Engineering and specializing in modeling the interactions of surface water and ground-water resources; Marci Koski, whose Ph.D project concerns food web relationships, tropic dynamics and how they relate to water quality and other aspects of aquatic ecology in western reservoirs; and Colleen Green, whose research topic will involve runoff and leaching studies with vegetative buffer strips in urban areas versus agricultural areas, where manure has been applied for at least 10 years. Reports by each student on their research progress are summarized below.

From left: Fellow Garey Fox, Professor Jim Loftis, Civil Engineering Department, Fellow Colleen Green, Professor Jessica Davis, Department of Soil and Crop Sciences, and Fellow Marci Koski.

Water Fellowship Progress Report by Colleen Green

During the past year I selected and prepared a field site for establishing a vegetative filter strip (VFS), using an area owned by Horton Feedlot, Inc. that holds 10,000 head of cattle and drains into a catchment below the site. I plan to design an overland flow irrigation system that uses the water from the catchment and displace it onto the VFS. The intent is for the VFS to capture the nutrients and sediment so that cleaner water can be used for crop irrigation without concern of pollutant discharge or accumulation of excessive rates of nitrate or phosphorous (P). I am currently sampling three catchments owned by Horton Feedlot, Inc. Water quality monitoring will continue throughout the next 19 months to determine seasonal variability as well as the extremes of nutrient concentrations in the catchments.

A greenhouse study has commenced to determine the contract life of a VFS with and without alum water treatment residual (WTR) applied at 6 different rates. An optimum application rate will be determined that has enough P for plant growth but that minimizes runoff P. Laboratory studies to determine adsorption/desorption rates of P on the soil from the field site are beginning. Water quality analyses from the catchments and other soil analyses ($CaCO_3$ content, organic C content, soil texture, CEC, pH, etc.) using the ICP and various methodologies have also started.

My graduate committee includes: Advisor, Ken Barbarick, Department of Soil and Crop Sciences; Co-advisor, Roger Smith; and committee members Dean Heil, Jessica Davis, and Greg Butters, Department of Soil and Crop Sciences.

Water Fellowship Progress Report by Marci Koski

During the past year I worked on several water-related assignments, including gathering and compiling data and database construction for the Eutrophication of Reservoirs on the Colorado Front Range project; preparing two manuscripts for publication ("Functional response of kokanee (*Oncorhynchus nerka*) to *Daphnia* at different light levels" and "Size selectivity exhibited by kokanee (*Oncorhynchus nerka*) feeding on *Daphnia* under different light intensities"); and writing my Ph.D. proposal.

Briefly, the Ph.D. proposal outlines my project in three phases: 1) reconstructing the Stockwell and Johnson 1997 model in Excel and implementing the Koski and Johnson 2000 functional response model, 2) simulating the effects of eutrophication and climate change on aquatic food webs, and 3) simulating the effects of *Mysis* addition into a reservoir ecosystem. This fall my committee was formed (Brett Johnson, Ken Wilson and Alan Covich, Department of Fishery and Wildlife Biology; and Jim Loftis, Department of Civil Engineering). The committee will reconvene during the spring semester to discuss my Ph.D. proposal.

In the Fall of 2001, I participated in the annual CSU Water Symposium. My poster, "Modeling the interactive effects of eutrophication and climate change on kokanee (*Oncorhynchus nerka*) foraging behavior," presented some preliminary modeling results for my Ph.D. project. The poster was given the "Best Poster" award.

Water Fellowship Progress Report by Garey Fox

My dissertation topic focuses on the analytical modeling of surface water/groundwater interaction in stream/aquifer systems. Irrigation water rights in the western United States make use of critical stream depletion estimates when pumping adjacent to partially penetrating streams. Surface water depletions and corresponding water rights decisions in the western United States are typically based on analytical solutions that oversimplify physical conditions. My research will be aimed at developing an integrated stream/aquifer analytical package capable of simulating more physically representative stream/aquifer systems. A paper based on early research was presented at Hydrology Days and a presentation was also made at the CSU Student Water Symposium:

Fox, G.A. and D.S. Durnford. 2001. Investigation of analytical and numerical models for simulating surface water/groundwater interaction. Proceedings of the 21st Annual Geophysical Union Hydrology Days, April 2-5, Fort Collins, CO.

Fox, G.A. 2001. "Advances in the analytical modeling of stream/aquifer interaction." 5th Annual Colorado State University Student Water Symposium, November 7-9, Fort Collins, CO.

Two papers based on improved models have been submitted for publication in *Ground Water*:

Fox, G.A., P. DuChateau, and D.S. Durnford. 2002. Analytical model for distributed stream leakage. *Ground Water* (In Review).

Fox, G.A. and D.S. Durnford. 2002. Stream/aquifer interaction with partial penetration, well-bore storage, and well-skin effects. *Ground Water* (In Review).

My committee members are Deanna Durnford, Jorge Ramirez and Luis Garcia, Department of Civil Engineering; and Bill Sanford, Department of Earth Resources.

Colorado State University invites applications for three USDA National Needs Fellowships in Natural Resources and Environment to begin fall 2002 through fall 2003. Fellows must be U.S. citizens and must have completed an M.S. degree. Awards will be made as soon as outstanding candidates have been identified. For more information and application materials contact Dr. Jim Loftis, loftis@engr.colostate.edu. Colorado State University is an EEO/AA employer.

RESEARCH

THE IDENTIFICATION, HISTORICAL DISTRIBUTION, AND HABITAT REQUIREMENTS OF BRASSY MINNOW IN COLORADO PLAINS STREAMS

by Julie A. Scheurer and Kurt D. Fausch
Department of Fishery and Wildlife Biology
Colorado State University

In Colorado, six of 38 native plains fish species are known to have been lost since the first fish collections were made in the late 1800s. An additional 13 species are listed by the state as endangered, threatened, or of special concern – therefore, half of the native fish have either declined or been lost. The brassy minnow (Hybognathus hankinsoni) is one of three plains fish species listed as threatened or endangered by the State of Colorado in 1998, due to an apparent decline in distribution and abundance in Colorado since the 1970s. To help fishery managers locate suitable habitat and potentially restore the species to more of its native range and preclude the need for further listing, this research project sought to determine the historic distribution and critical habitat requirements of the brassy minnow.

Understanding the native range of brassy minnow is complicated, because it is difficult to distinguish the brassy minnow (*Hybognathus hankinsoni*) from a closely related species that also occurs in the region, the plains minnow (*H. placitus*). In addition, both species were originally classified as a different species in the same genus (Mississippi silvery minnow, *H. nuchalis*) before they were first described in 1929 (brassy minnow) and l962 (plains minnow). As a result, many early collections from Colorado and adjacent counties in neighboring states were classified as Mississippi silvery minnow, even though this species does not occur in Colorado, and many later collections were misclassified as the wrong species due to their similarity. Research investigators developed a method to distinguish the species identity of collections from Colorado and adjacent counties using eye diameter, standard body length, and eye position. This method correctly predicted species identity for 98 percent of the individual fish and 100 percent of the museum collections.

In general, brassy minnow have larger eyes with centers even with the tip of the snout, whereas plains minnow have smaller eyes centered above the tip of the snout (Fig. 1). **Reference collections of these species are housed at the CSU Larval Fish Laboratory.**

In 1999, the first year of this study, researchers sampled locations throughout eastern Colorado where brassy minnow had most recently been collected. The Arikaree River (Fig. 2) was selected to determine the ecological requirements of the brassy minnow, because it presented a unique opportunity to study population dynamics at three spatial scales (habitat unit, segment, basin) across a gradient of stream intermittency (i.e., drying). This allowed investigators to determine the brassy minnow's thresholds of tolerance and assess how much perennial water is necessary to sustain populations.

Ninety-nine habitat units (pools, backwater pools, and runs) in three 4-mile segments ranging from perennial to seasonally dry were sampled during five surveys in 2000 and 2001, the two driest summers on record. For each survey, participants measured habitat variables in each unit, mapped flow connections between habitat units, and sampled each unit using two-pass depletion seining to determine the presence or absence of brassy minnow. Basin-scale flow connectivity was also mapped three times by aerial flights along the 66-mile mainstem of Colorado's Arikaree River.

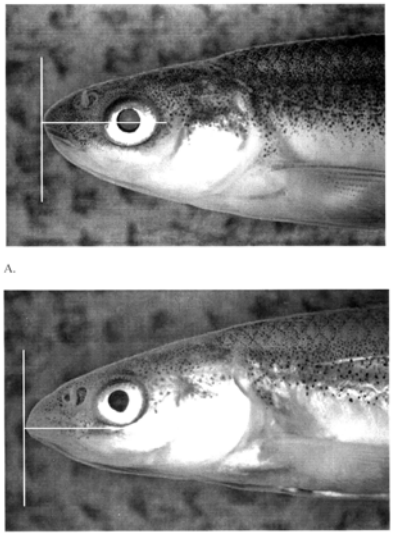

Fig. 1. Eye position characteristics for brassy minnow (top) and plains minnow (bottom). Photos by R.E. Zuellig.

At the basin scale, total habitat for brassy minnow was restricted to about 47 miles of the mainstem Arikaree River upstream from the confluence, but during early summer 2001 only a 16-mile stretch that contained the researchers' selected upstream segment had continuous flow. At the segment scale (upper, middle, downstream), drying occurred in all segments each summer, but was most pronounced in the downstream segment. The middle segment was intermediate in its degree of drying and the upstream segment had the most perennial habitat.

> ***The amount of available habitat, number of habitat units occupied by brassy minnow, persistence of brassy minnow through summer drying, and extent of recolonization after the channel rewetted were highest in the upstream segment and lowest in the downstream segment, corresponding to the gradient of flow intermittency.***

Of the 86 pools sampled across the three segments in 2000, brassy minnow were present in 65 during at least one survey. They persisted through summer 2000 in about half of the pools where they were present, were extirpated from 17 pools by stream drying, and emigrated to adjacent habitat units or were not present in the 18 pools that remained wet. The researchers first identified factors that predicted brassy minnow persistence in pools that remained wet through the summer drought, and then predicted which pools would persist through summer drying.

Models of brassy minnow persistence through August 2000 were developed using variables measured at both the pool and segment scales. Then, because drying was the dominant mechanism affecting brassy minnow persistence, models of pool persistence through August 2000 were developed based on variables measured in June.

> ***Logistic regression showed that brassy minnow were more likely to persist through the summer in deeper pools connected to other habitats, and more likely to persist in pools in the upstream segment. The main cause of elimination was by pool drying, which logistic regression showed was more likely in pools with shallower June depths.***

For example, a pool with a maximum depth in June of 0.5 meters would have only a 50 percent probability of persistence in the downstream segment, but a 77 percent probability of persistence in the middle segment and a 95 percent probability in the upstream segment. Thus, shallower pools

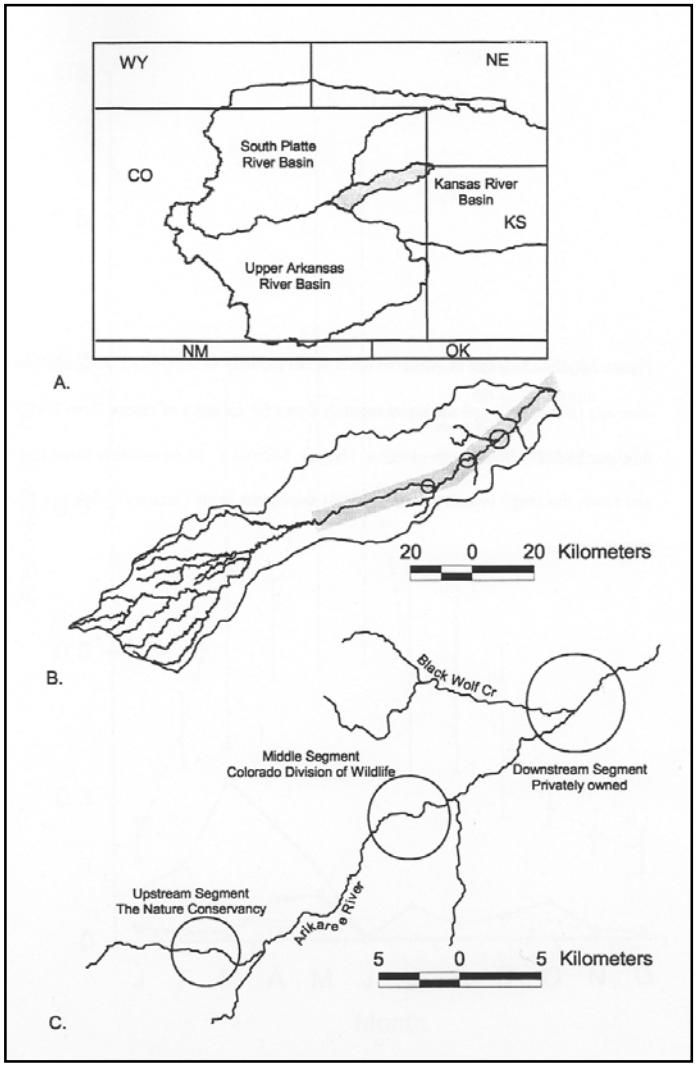

Fig. 2. Location of the basin and study segments

were more likely to persist in the upstream segment and more likely to dry in the downstream and middle segments.

Because brassy minnow were tolerant of high water temperature (36C=97F) and low dissolved oxygen (as low as 0.01 mg/L), other factors, such as predation by terrestrial vertebrates and pool drying, likely had a greater effect on their persistence. Overall, the patterns of stream drying at the segment scale were more important predictors of brassy minnow population persistence than water chemistry or habitat features measured at the local or pool scale.

In addition to persistence of brassy minnow and their habitat, we compared several measures of brassy minnow population performance among segments, including survival, growth, and reproductive success.

> ***Brassy minnow survived to older ages and were larger at older ages in the most perennial segment compared to the others. However, despite poor adult survival in the drier segments, brassy minnow larvae were present in all three segments in both years, indicating that they are capable of reproduction and rapid recolonization when water is available.***

Brassy minnow spawned from mid-April to mid-May and larvae appeared from mid-May through mid-June. The beginning of larval hatching coincided with the onset of pumping for irrigation and rapid dewatering of the driest segment, which killed most larvae.

For many fish populations living in "patchy" environments, such as streams that are seasonally intermittent, persistence at the regional scale depends on the balance between local extinction and colonization from adjacent patches that serve as refuges. Many seasonally intermittent steams are distinguished by marked wet and dry periods, so extinction and recolonization of fish populations are common. Extinction occurs primarily as streams dry, whereas recolonization is prevalent during the wet season. Understanding the processes that drive populations in such habitats requires examining the distribution of fishes at both local and regional scales and during cycles of wetting and drying. Groups of subpopulations that persist in a network of patches despite local extinctions are termed 'metapopulations.'

Only a few studies have addressed whether stream fish populations are arranged as metapopulations, despite numerous studies of movement, extinction, and colonization patterns. However, several studies provide good evidence that metapopulation processes are at work in stream fish populations. Researchers have found that fish apparently move relatively long distances to recolonize pools where previously fish had been eliminated by drought or freezing.

If any stream fish are likely to show metapopulation processes, fishes of the Great Plains are good candidates. Plains streams are harsh environments that fluctuate drastically in both physical and chemical properties due to flash floods that rearrange habitat, seasonal drying, and winter freezing. The extreme conditions created by these natural processes are often exacerbated by land and water use practices. Understanding the role of metapopulation processes in sustaining rare and declining species is important for managers, because their goal is to achieve regional persistence of these species and their habitats.

Brassy minnow in the Arikaree River showed evidence of metapopulation dynamics because persistence was related to patch size (depth) and isolation, with extinctions more likely in shallow, disconnected pools. Moreover, some suitable habitats were empty, there were asynchronous local dynamics among pools, and the species persisted at the segment (regional) scale despite population turnover. The dynamic nature of plains streams, differences in flow regimes among segments, and the large scales over which brassy minnow fulfill their life history require management at the 'intermediate' segment scale for effective conservation.

This research showed that brassy minnow are very tolerant of harsh conditions, move relatively long distances to recolonize empty habitat, and produce offspring even during the driest years on record. This suggests that the declines observed from 2000 to 2001 could be offset by a series of wet years. However, a prolonged drought could extinguish brassy minnow from most of the basin, and recolonization could take many years once favorable conditions return.

RECOMMENDATIONS

The following measures are recommended to improve habitat conditions in the Arikaree River and enhance brassy minnow populations:

- ***Increase spring flows to prevent early drying of the downstream segment and improve survival of brassy minnow larvae.***
- ***Maintain riparian and stream processes that create deep pools and provide critical refuges for brassy minnow during summer drying.*** Intact riparian vegetation binds stream banks and allows deep pools to be carved by periodic floods from summer thunderstorms. In addition, beaver dams often create deep pools that persist through summer.

- ***Maintain the native fish community and prevent invasion of exotic predators or competitors.*** Although most nonnative fishes apparently cannot withstand the harsh physicochemical conditions of plains streams, off-channel ponds supplied by groundwater can provide refuges that harbor nonnative predators like largemouth bass. These fishes can emigrate and decimate native fishes in adjacent stream habitats.

- ***Investigate the effects of irrigation on groundwater hydrology that maintains stream flow and permanent refuge pools. These pools and backwaters are critical for brassy minnow larval and adult survival during periods of summer drying and winter freezing.*** A better understanding of the linkages between land and water use and plains fish populations at segment scales will be needed for effective conservation of these fishes.

This research was performed with the support and collaboration of the Department of the Interior, U.S. Geological Survey; the Colorado Water Resources Research Institute, Colorado State University; and the Colorado Division of Wildlife.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

The authors would like to express their appreciation to the cooperative landowners of the Arikaree valley, the Nature Conservancy, and volunteers who assisted with the fieldwork, laboratory and data management, museum collections, and photographic services. Dr. Kevin Bestgen, Department of Fishery & Wildlife Biology, Colorado State University, verified the identities of all museum collections.

WATER SUPPLY

This month's SWSI values dropped as the snowpack figures drop. The March 1 statewide snowpack is 56 percent of normal, which is a drop from the February 1 figure of 58 percent of normal. All SWSI values are below last month's vaslues. They are also lower than last year's values. The Rio Grande and San Juan/Dolores River basins show the largest fluctuations from last year.

All graphed index stream flows are currently below normal, ranging from 91 percent of normal for the Uncompahgre River near Ridgewar to 55 percent of normal for the Colorado River at Dotsero. The NRCS forecasted runoff volumes for this spring and summer are well below average, with most below 70 percent of normal and many areas in below 50 percent of normal. Direct flow water users, especially those with junior priorities, should be planning for reduced water supplies this year.

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the USDA Natural Resources Conservation Service is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on snowpack, reservoir storage, and precipitation for the winter period (November through April). During the winter period, snowpack is the primary component in all basins except the South Platte basin, where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven major basins for March 1, 2002, and reflect the conditions during the month of Februarv.

Basin	3/1/02 SWSI Value	Change from the Previous Month	Change from the Previous Year
South Platte	-2.0	-0.1	-1.8
Arkansas	-2.5	-0.3	-0.5
Rio Grande	-3.1	-0.4	-4.6
Gunnison	-2.8	-0.4	-1.1
Colorado	-2.8	-0.2	-1.0
Yampa/White	-3.2	-0.2	-0.2
San Juan/Dolores	-3.1	-0.5	-2.9

SCALE								
-4	-3	-2	-1	0	+1	+2	+3	+4
Severe Drought		Moderate Drought		Near Normal Supply		Above Normal Supply		Abundant Supply

DEVELOPMENT OF A MANURE SAMPLING PROTOCOL AND A MOUNTAIN WEST MANURE DATABASE

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The over-application of manure has often been implicated in the contamination of groundwater and surface water sources with nitrogen and phosphorus. Land-grant universities throughout the U.S. recommend that farmers sample and analyze animal manure in order to determine the nutrient content prior to land application. The determination of agronomic manure application rates that will not result in nutrient leaching or runoff is dependent on accurate manure nutrient information.

Many universities provide table values for use when producers do not have good analyses of their own. However, table values commonly used today are now 15-20 years old and have been re-published so often, that it is often difficult to ascertain the original source (Rieck-Hinz et al., 1996). On the other hand, very few livestock producers actually do site-specific manure sampling, which has led us to question the rationale behind manure sampling.

We had several questions regarding the effectiveness of manure sampling by producers and the use of table values. How variable are nutrient contents in manures and how many sub-samples would be required to make sampling and testing worthwhile? Can table values provide reasonable estimates when farmers do not have analyses from their own operations? Do regional differences in climate and management systems require us to develop state-by-state databases of manure nutrient contents?

There are very few published data that address these concerns. Manure nutrient content is known to be variable (Rieck-Hinz et al., 1996), but exactly how variable and the implications of that variability for sampling protocol have not been reported or defined, except for a recent paper by Dou et al. (2001). Dou et al. (2001) collected serial samples from dairy, swine, and broiler poultry operations while they were being loaded for field application. They found that when agitation was used prior to loading, CVs (the coefficients of variation) were 6-8 percent within farm, and three to five sub-samples were adequate for a representative composite sample. Where no agitation was used, CVs ranged from 20-30 percent, and at least 40 sub-samples were required.

The variability in manure nutrient contents across herds and within farms has been rightly attributed to differences in feeding practices, breed and age of the animal, manure handling practices, and environmental conditions, and led us to question the use of table values.

The objectives of this study were to:

- Measure the variability within stockpiles and lagoons of various animal manures and determine the number of sub-samples needed to characterize the nutrient content within 10% probable error.
- Compare Colorado manure analyses to the table values we have been using in our publications, which come from Midwestern data.
- Develop a database of manures from Colorado samples and determine if we can include manures from neighboring states into a "Mountain West" database.

Within Stockpile/Lagoon Variability and Sub-Sample Requirements

We collected 10 sub-samples from each of five manure stockpiles (beef, dairy, horse, sheep, chicken) and two finished manure composts (dairy, turkey). Each sub-sample was analyzed separately for dry matter (D.M.), total N, NH_4-N, NO_3-N, P, and K to determine the variability within the pile or lagoon.

To determine the number of sub-samples needed (N_{est}) we used the equation,

$$N_{est} = t^2CV^2/p^2,$$

from Upchurch et al. (1988), where *t* is Student's *t* value for a specified probability (in this case, for a 95 percent confidence interval), *CV* is the coefficient of variation, and *p* is a percent probable error (in this case, 10 percent).

The variability of samples within a manure stockpile differed for the various constituents. Ammonium and nitrate had the greatest variability. The greater the variability, the greater number of sub-samples required for useful analyses (Table 1).

Table 1. Number of subsamples needed to characterize Colorado animal manure stockpiles within 10% error at 95-percent confidence level.

Manure type	N	P	K	NH_4-N	NO_3-N	D.M.[1]
	----------number of subsamples needed----------					
Beef manure						
Dairy manure	17	20	32	121	692	3
Horse manure	19	49	14	255	1914	22
Sheep manure	17	11	14	211	802	12
Chicken manure	13	23	19	360	688	7
Mean of solid manures	55	31	27	443	147	43
	24	**27**	**21**	**278**	**849**	**17**
Dairy compost						
Turkey compost	1	5	119	92	191	2
Mean of composts	40	26	13	128	440	2
	21	**16**	**66**	**110**	**316**	**2**

[1] D. M. = dry matter

For example, to achieve probable error within 10 percent for a beef manure stockpile, one would need 17 sub-samples to characterize total N, 20 sub-samples for P, 32 for K, 121 for NH_4-N, and 692 sub-samples for NO_3-N.

With solid manures, it seems possible to estimate the total N, P, and K in a stockpile within 10 percent probable error with a moderately intensive sampling plan (21-27 sub-samples). However, to characterize the NH_4-N and NO_3-N levels in order to predict N availability to crops, the required sub-sample number becomes impractical (> 100).

Comparison to Midwestern Table Values

Five types of solid manures (beef, dairy, horse, sheep, and chicken) were sampled throughout eastern Colorado. For each type, six to ten different livestock operations were sampled. Each sample was a composite of six sub-samples taken from different locations and depths within the stockpile. Means for each characteristic (dry matter, total-N, NH_4, P_2O_5, and K_2O) from these samples and those piles sampled for Objective 1 (average of 10 sub-samples), were compared with the values we previously used in our extension publications, which came from Midwestern manure samples (Loudon, 1985).

The dry matter contents of the Colorado manures were consistently higher than those from the Midwest (Table 2). On a fresh-mass basis, the Colorado manures had higher total N contents in four out of five cases. Ammonium was lower in all of the Colorado manures on a fresh-mass basis. Colorado P_2O_5 and K_2O contents were higher than Midwestern data for all manure types.

The semi-arid and windy climate of Colorado leads to greater evaporation of water and volatilization of NH_4-N from manure stockpiles resulting in the higher dry matter values and lower contents of NH_4-N in all of the manures. Phosphate and K_2O contents are greater in Colorado manures because of the concentration effect from the greater loss of water. This concentration effect also occurs with organic N, causing the increase in total N content in most of the manures.

Mountain West Manure Database

Manure samples from three "Mountain West" states (Colorado, New Mexico, and Utah) were combined into one database. The data were gathered from analyses that had been accumulated by extension soil scientists in those states. These samples represent a variety of animal types, material types (solid, liquid, and composted), years (1993 to present), and sources. The mean and the 90-percent confidence interval (C.I.) were calculated for each manure type.

Table 2. Comparison of solid animal manures from Colorado and the Midwest (fresh-mass basis).

Manure type		N	DM	Total N	NH_4-N	P_2O_5	K_2O
			--%--	----------lbs/ton----------			
Beef	Colorado	11	68	23	3	24	41
	Midwest		52	21	7	14	26
Dairy	Colorado	8	54	13	2	16	34
	Midwest		18	9	4	4	10
Horse	Colorado	9	78	19	1	14	36
	Midwest		46	14	4	4	14
Sheep	Colorado	9	69	29	2	26	38
	Midwest		28	18	5	11	26
Chicken	Colorado	9	60	30	8	64	39
	Midwest		45	33	26	48	34

The database of manure samples from Colorado, New Mexico, and Utah is summarized in Table 3. Although the data set includes a large number of manure types, few of them include large sample numbers from more than one state. Only one manure type (solid beef manure) has more than 100 samples in the database, and these are mostly from one state (Colorado).

Table 3. Means and confidence intervals of manures from Colorado, New Mexico, and Utah.

Manure type	D.M.[1]			N[2]			P_2O_5[2]			K_2O[2]		
	n	Mean	C.I.	n	Mean	C.I.	n	Mean	C.I.	n	Mea n	C.I.
Beef solid	103	62	60 – 65	103	23	21 – 24	84	23	22 – 25	84	33	31 – 34
Chicken compost	12	54	45 – 62	12	26	24 – 29	12	70	57 – 82	12	33	28 – 38
Chicken solid	14	64	56 – 72	14	48	33 – 62	14	62	54 – 69	14	41	35 - 46
Dairy compost	38	77	74 – 80	36	23	21 – 26	36	22	19 – 24	36	43	37 – 48
Dairy liquid	18	1	0 – 2	23	5	3 – 7	23	2	1 – 4	23	5	3 – 7
Dairy solid	78	63	59 – 66	62	25	23 – 28	51	18	16 – 20	51	35	31 – 39
Hog liquid	9	0	0 – 0	9	2	1 – 3	9	1	1 – 1	9	5	3 – 7
Hog solid	6	43	20 – 67	6	11	2 – 20	3	44	0 – 128	3	9	0 – 32
Horse solid	9	78	73 – 82	9	19	15 – 22	9	14	12 – 16	9	36	34 –41
Llama solid	3	79	66 – 92	3	28	11 – 45	3	24	15 – 33	3	54	21 - 87
Sheep solid	12	67	59 – 67	12	28	25 – 31	10	26	22 – 30	10	39	34 – 44
Turkey compost	6	68	66 – 71	6	38	33 – 43	6	81	73 – 88	6	46	38 – 53
Turkey solid	9	90	84 – 96	9	63	55 – 72	9	77	63 – 92	9	37	32 – 41

[1]Means and C.I. in %. [2]Means and C.I. in lbs/ton for solids and composts; lbs/1,000 gal for liquids.

The confidence interval (C.I.) is a measure of the probability that a sample will fall within an upper and lower limit (Table 3). For the one case in which we had over 100 samples (solid beef manure), the C.I.s were extremely narrow. For example, the mean total N content for beef manure was 12 kg/Mg (23 lbs/ton), with a C.I. of 10-12 kg/Mg (21 - 24 lbs/ton). We can interpret this to mean that nine out of ten beef manure stockpiles will have a N content between 10 and 12 kg/Mg (21 and 24 lbs/ton). For means with small sample sizes, the C.I.s were often larger, making our table values less precise. We hope that we can improve these C.I.s by including more samples of these manure types in our database.

CONCLUSIONS

Dry matter and nutrient content vary considerably within manure types. About 25 sub-samples are usually sufficient to characterize total N, P_2O_5, and K_2O within 10% error. It is impractical to sample manure for NH_4-N and NO_3-N due to the excessive variability. Producers would be better off using total N values alone for predictions of N availability to crops.

Colorado manure nutrient contents and dry matter were different from the Midwestern values we had been using in our extension publications. Dry matter was higher in Colorado due to higher evaporation in our semi-arid climate. The P_2O_5 and K_2O contents were greater in Colorado samples. Ammonium was lower in Colorado, probably due to greater volatilization in our drier and windier climate.

For now, we plan to base most recommendations on Colorado samples. Until we have 25 or more samples and tight confidence intervals for all manure types, we will continue to recommend that livestock producers sample and test their livestock manure. However, if they will not sub-sample adequately (n > 20), they should use our new Colorado-based table values for best results and follow up with soil testing.

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WATER SUPPLY OVERVIEW

Water Year 2001 -- The 2001 water year (Oct. 1, 2000 – Sept. 30, 2001) was the fourth year in a row with below average snowpack statewide as of April 1 and the second year in a row with below average precipitation and very warm temperatures. There were wide variations in precipitation each month and for the year as a whole, but precipitation ended up 95 percent of average statewide. The driest portion of Colorado was the northern and central mountains and western valleys. Snowpack was below average in all areas except over south central Colorado, where the Rio Grande basin experienced a very snowy winter. With warm spring and summer temperatures, the snows melted quickly and streamflow peaked earlier than average. Except for southern Colorado, 2001 streamflow volumes were below average and were only 60-80 percent of average on many of the larger rivers and streams. The trend toward reduced reservoir storate that began in 2000 continued. Statewide reservoir storage dropped to 93 percent of average by the end of September 2001, the lowest level in several years. *Abstract of a paper presented by Nolan Doesken, Colorado Climate Center, Colorado State University; and Michael A. Gillespie, Snow Survey Division, Natural Resources Conservation Service, USDA at Hydrology Days, April 1-4, 2002, at CSU.*

Water Year 2002 -- The Colorado Drought Task Force met March 21 and reviewed information provided by the national Climate Diagnostics Center, NRCS, State Division of Water Resources, and others. Statewide snow pack was 56 percent of average (March 1) and 60 percent of average (March 21). Data (March 1) shows that 56 percent is the third lowest snowpack for the period 1968 to 2002. Snowpack was 38 percent of average in 1977 and 40 percent in 1981. A major difference between those years and 2002 is that there has been below average snowpack in the four preceding years (1997-2001). Statewide snowfall would have to be 276 percent of average for snowpack to reach average by April 1.

The Bureau of Reclamation maintains data regarding reservoir capacities and contents. Those reservoirs having above average content include: Blue Mesa (116 percent), Morrow Point (111 percent), Vallecito (104 percent), Carter Lake (101 percent) and Taylor Park (102 percent). Others have less than average water content with the CBT Projects having a total of 72 percent of average and the Fry-Ark reservoirs totaling 81 percent of average. It is expected that the projects will not fill with spring run-off. *by Jeffrey E. Tranel, Agricultural & Business Management Economist, Colorado State University.*

More detailed information can be found at the websites indicated below.

http://www.atmos.colostate.edu/
http://www.co.nrcs.usda.gov
http://www.cpc.ncep.noaa.gov
http://www.nws.noaa.gov/
http://cwcb.state.co.us/Fact_Sheets/Drought_Assessment_Final.pdf

ASSESSING COLORADO GROUND WATER QUALITY AND VULNERABILITY

by Troy Bauder, Reagan Waskom and Zac Ceplecha
Department of Soil and Crop Sciences
Colorado State University
and
Brad Austin
Colorado Department of Public Health and Environment

In recognition of the importance of ground water resources in Colorado, the state legislature passed the Agricultural Chemicals and Groundwater Protection Act in 1990 to enact a program to prevent ground water contamination from pesticides and fertilizers. One of the statutory requirements of this program is to assess the likelihood of aquifer contamination. Obviously, an extensive ground water monitoring network would provide the most reliable data on ground water quality and vulnerability to impacts from surface activities. The Colorado Department of Public Health and Environment (CDPHE) has worked with the Colorado Department of Agriculture (CDA) to develop such a network since 1992. However, the expense of ground water monitoring limits the spatial and temporal extent of the data and the ability to determine where additional measures are needed to protect vulnerable ground water resources. A tool to model and predict ground water vulnerability may be the best option for identifying where the risk of contamination is most probable.

To date, the Agricultural Chemicals and Groundwater Protection program has analyzed water quality samples from over 800 individual domestic, irrigation and monitoring wells throughout Colorado. A suite of organic and inorganic constituents has been analyzed and a general picture of ambient ground water quality in Colorado is emerging. Elevated NO_3-N levels may be used to identify areas where ground water is vulnerable to contamination from surface activities and land use. In Colorado, NO_3-N levels tend to be highest in the irrigated river valleys where there is a long history of crop production, animal feeding, and municipal discharges (Fig.1).

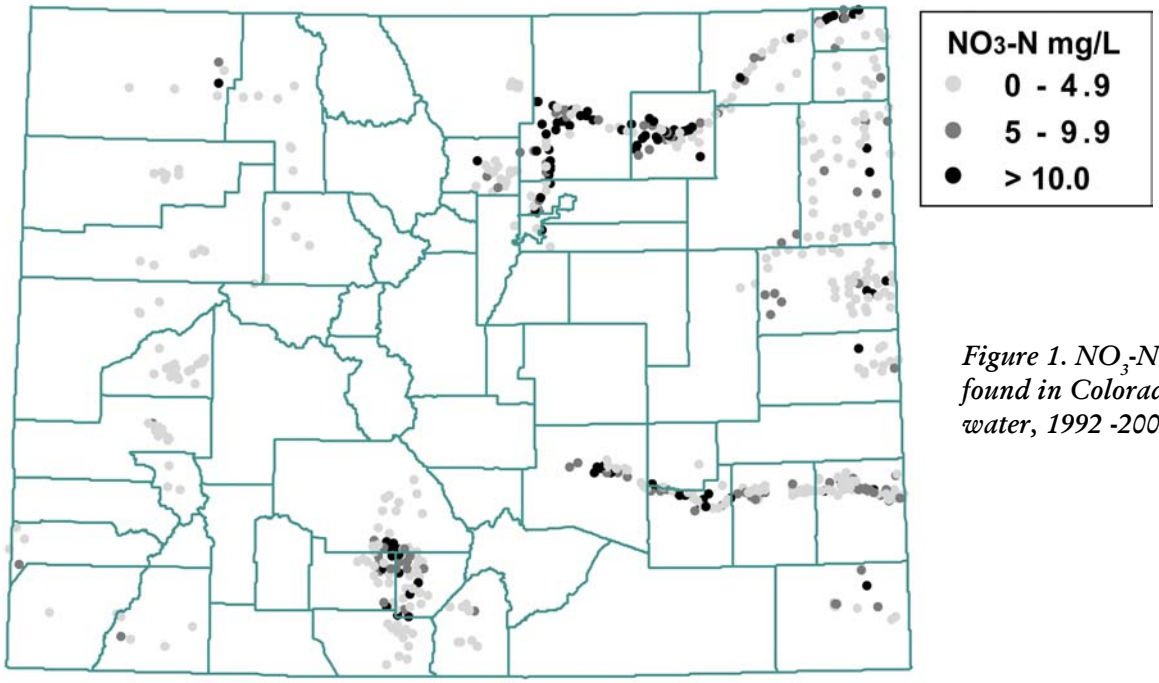


Figure 1. NO_3-N levels found in Colorado ground water, 1992 -2001.

Elevated levels of total dissolved solids (TDS) may be used as a surrogate to indicate areas where ground water is of poor quality due to natural processes. In Colorado, high levels of TDS may be found almost anywhere, but tend to be prevalent in the river valleys also (Fig. 2). These water quality data, combined with knowledge of the areas of the state where ground water is the primary source of drinking water (Fig. 3), begin to paint a picture of where financial, human and technical resources are most needed to protect high-quality ground water from unacceptable levels of contamination. For example, the ground water in the High Plains of eastern Colorado tends to have low TDS and NO_3-N levels, yet it is the sole source of drinking water for many rural residents and public water suppliers, underscoring the need to protect this important resource. However, is it prudent to assume that these ground water supplies are safe from future contamination based solely on limited monitoring data?

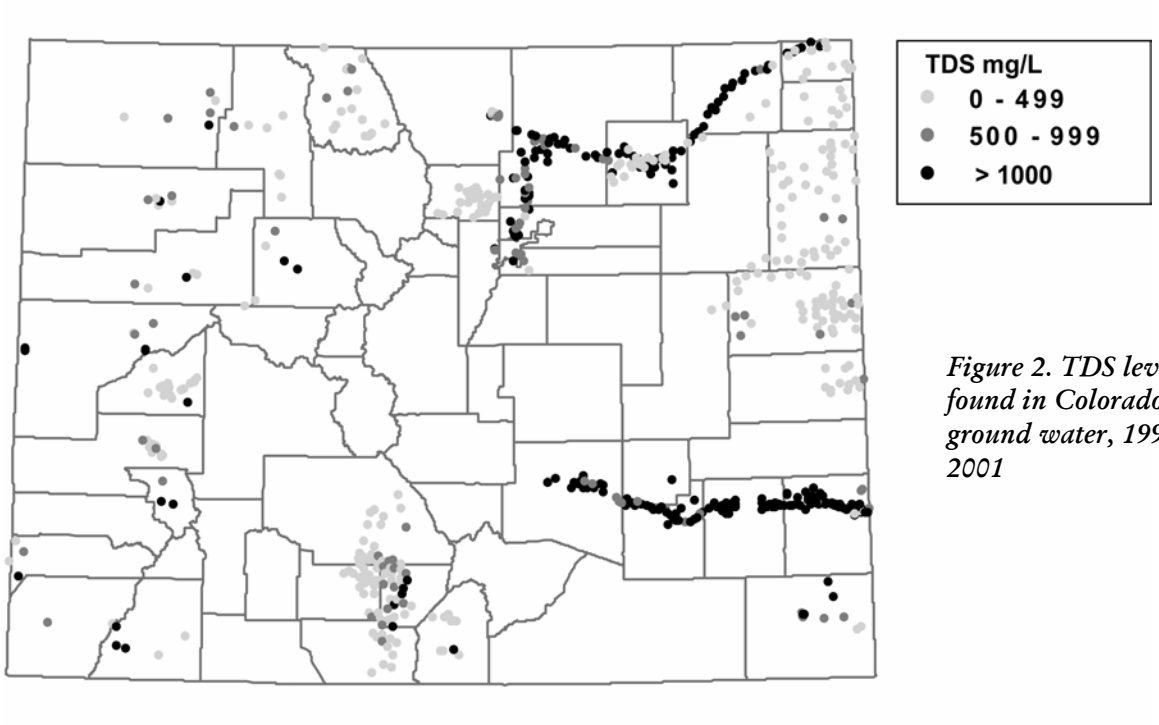


Figure 2. TDS levels found in Colorado ground water, 1992 - 2001

To address this uncertainty, the Agricultural Chemicals and Groundwater Protection Program, in concert with scientists at Colorado State University, Colorado School of Mines, and the USGS have begun assessments of ground water vulnerability. This research involves the development of two levels of aquifer vulnerability assessment. The first is a statewide aquifer vulnerability map that is used to identify areas within the state that have a relatively higher risk of contamination than others; the second tool helps farmers assess leaching potential on a field scale. This article focuses on work on the statewide vulnerability assessment recently completed by an M.S. student at Colorado State University (Ceplecha, Z. 2001. Sensitivity and vulnerability assessment of Colorado ground water to nitrate contamination. M.S. Thesis, Colorado State University).

Building on earlier work by Maurice Hall (CSU Ph.D. Dissertation, 1996), five factors (with available spatial data) were used to build an aquifer vulnerability map for Colorado. This map is designed for visualizing vulnerability only on a regional scale. With Geographic Information System (GIS) and various spatial data sets, a numerical value is assigned for each variable included in the assessment, according to relative importance to regional ground water quality. Once the values have been assigned, the data comprise a map layer in the GIS. These map layers are then combined in the GIS to produce the final aquifer vulnerability map.

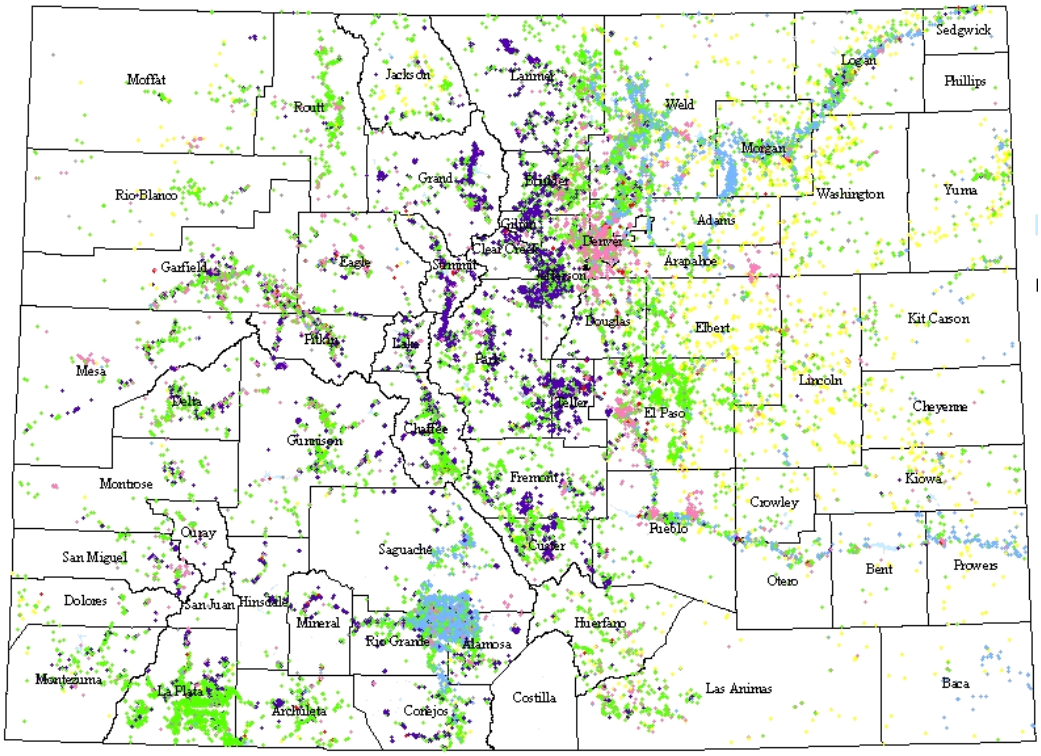


Figure 3. Location of ground water wells (< 100 ft. deep) identified in the Colorado Office of the State Engineer database.

Factors used to develop the map are:

1. Location of Productive Aquifers: The presence or absence of one or more principal aquifers was selected as an indicator of productive and more vulnerable aquifers.
2. Depth to Water: Depth to water affects the length of time required for nitrate to reach the ground water.
3. Soil Drainage Class: Because nitrate is highly mobile with water in the soil environment, it is important to incorporate soil factors that reflect water movement and percolation into the vulnerability analysis.
4. Recharge Availability: The amount of water available for infiltration to ground water is an important consideration for nitrate movement in the semi-arid climate of Colorado. Evapotranspiration (ET) rates far exceed precipitation in most areas of the state. This means little water is available for infiltration and recharge to ground water. Due to the increased potential for recharge under irrigated agricultural land compared to natural recharge in Colorado, the presence of irrigation is used as the best indicator of recharge availability.
5. Land Use: Lastly, data defining different land uses in Colorado were obtained. The land use map was obtained from the National Land Cover Database (NLCD) in the United States Geological Survey (USGS) National Mapping Division. The land uses were originally classified by the USGS into 21 different classes. For this map, land use classifications were reclassified into four broad categories based on the associated importance of the land use to nitrate pollution: Open water and perennial ice; natural lands and wetlands; developed land; and agricultural lands. The irrigation coverage was then combined with the land use coverage to compose a fourth class.

The vulnerability map was created by incorporating the input factors into the map equation below, using the ArcView GIS software. The nitrate vulnerability map equation is:
((Land Use Index + Irrigation Index) +Drainage Index + Depth to Ground Water Index)* Presence of Aquifer

The map equation grouped 36, 54, and 10% of the total area of the state classified into the low, medium, and high vulnerability categories respectively. The effectiveness of the final vulnerability map was evaluated by comparing it to statewide ground water nitrate concentration data obtained from the USGS NAWQA and CDPHE monitoring programs. Validation determined the map was able to delineate general areas of increased aquifer vulnerability to nitrate contamination (Figure 4).

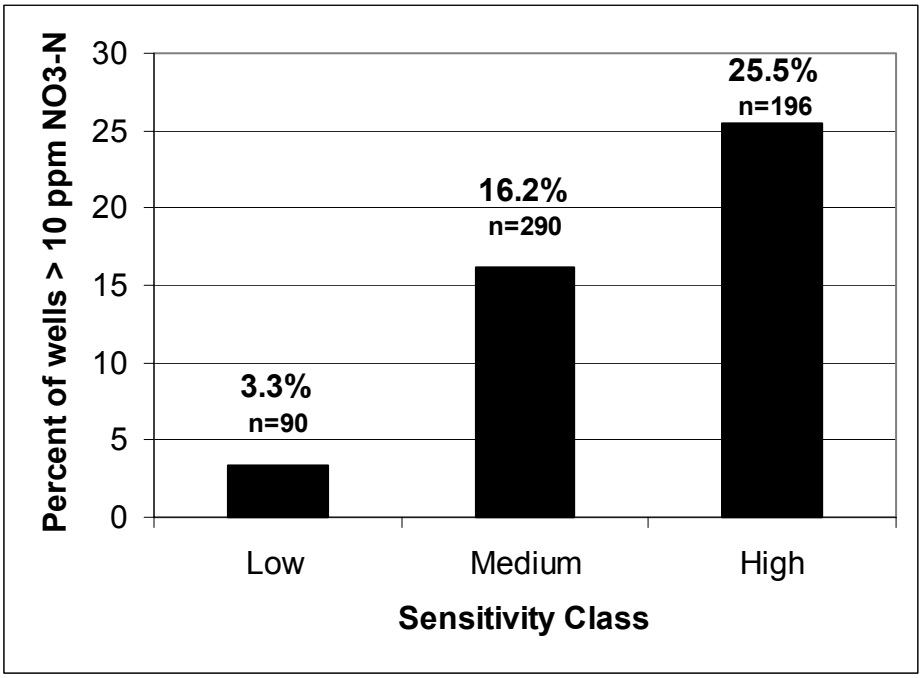


Figure 4. Percent of wells sampled with > 10 ppm NO_3-N in each sensitivity class identified by the nitrate vulnerability map.

The nitrate vulnerability map results indicate that several areas of Colorado are highly vulnerable to nitrate contamination (Fig 5). These include certain areas of the High Plains Aquifer that have not been shown to have elevated NO_3-N levels. These areas generally contain sandier soils and are irrigated. Spatial data is currently not available for management practices or other field specific factors that may change the risk of contamination from individual fields. Therefore, a field level assessment was developed by Ceplecha (2001) to more accurately evaluate site-specific risk.

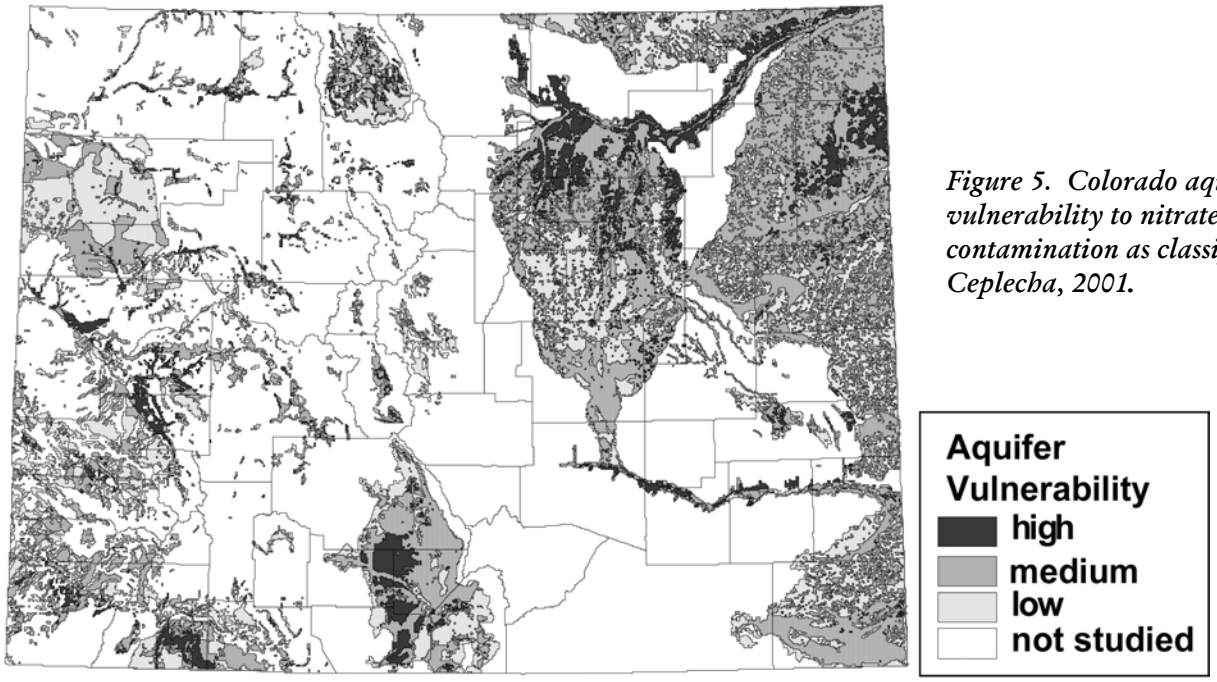


Figure 5. Colorado aquifer vulnerability to nitrate contamination as classified by Ceplecha, 2001.

In summary, ground water resources in Colorado vary in quality due to both anthropogenic and natural factors. These resources also vary in their predisposition to contamination from surface activities. Because contamination risk and the use of ground water varies, uniform management across the state or even from field to field is inefficient. Better knowledge of ground water contamination risk, coupled with a better quantification of the benefits expected from higher levels of protection, should help state natural resource and water quality agencies more efficiently utilize limited human and financial resources.

MEETING BRIEFS

FUNDING CHALLENGES FACE WATER INSTITUTE DIRECTORS AT ANNUAL MEETING

The 2002 Annual meeting of the National Institutes for Water Resources (NIWR) was held in Washington, D.C. March 3-5, 2002. Sixty directors and institute staff attended the meeting. NIWR is an association of state water institute directors from 50 states, three territories and the District of Columbia. The state water resources research institutes program is partially funded by Congress and administered under the U.S. Geological Survey.

The Universities Council on Water Resources (UCOWR) held one of its regular Board of Directors' meetings in conjunction with the NIWR meeting, and a number of UCOWR board members attended the NIWR meeting. The last day of the NIWR meeting was organized into a special overview session of federal water research opportunities and future plans and was open to all higher-education and federal scientists. Approximately 40 federal agency and university scientists joined institute directors for the special NIWR session. The results of this session will be available on the web at: http://wrri.nmsu.edu/niwr/

Left to right: Ken Reckhow, Director, North Carolina Institute; Karl Wood, Director, New Mexico Institute; and John Schefter, Chief, Office of External Research, Water Resources Division, USGS

The NIWR meeting is held annually to facilitate communication and water research planning among the 54 water institutes, improve the water institute program's effectiveness, update directors on national water research initiatives, coordinate with federal water research agendas and plans, and inform Congress of the water research and outreach work of the institutes. This year, keeping Congress informed takes on special meaning, as the President's FY03 budget eliminates funding for the national water institute program. Thus, many of the conversations between institute directors and their Congressional delegations focused on the importance of the national institute program's goal: to facilitate collaboration and cooperation in the planning and conduct of state-based and regional water research. The institutes connect federal, state, local and university water expertise to the water research and education needs of local, state and regional water users and managers in ways that few programs can accomplish.

Paul Godfrey, NIWR Executive Secretary and Director of the Massachusetts Institute, discusses cooperation between NIWR and UCOWR with UCOWR President Ari Michelsen.

During the first day of the annual NIWR meeting, a "new directors" workshop provided an overview of the water institute program and described the "bottom line" responsibilities of all institutes. Another session examined effective institute management via descriptions of how successful small, medium and large water institutes operate. The main theme throughout was to maintain the operational flexibility to meet changing water research and education

Alan Jones, Director of the Texas Institute, talks about research possibilities with Ed Link, U.S. Army Corps of Engineers.

needs, often within changing university arrangements for sponsoring the Congressionally authorized and funded institutes.

A later session examined new water research initiatives by the National Association of State Universities and Land-Grant Colleges (NASULGC) and the Consortium of Universities for the Advancement of Hydrological Sciences (CUAHSI). The latter initiative is examining, and addressing, the infrastructure needs associated with large-scale hydrological research. The National Science Foundation is seeding development of the new hydrological research infrastructure, and 51 universities now belong to CUAHSI.

Monday morning, March 4th, the Director of the U.S. Geological Survey, Chip Groat, and Associate Director for Water, Bob Hirsch, discussed the ongoing value of the unique collaboration between the USGS and universities represented by the national water institute program. In a time when enhanced collaboration and coordination in water research and education are being sought, there are existing institutional arrangements ready and able to meet the challenge.

Henry Vaux, immediate past Chair of the Water Science and Technology Board (WSTB) of the National Research Council, provided an overview of the current status of water research in the U.S. based upon the recently completed WSTB report entitled: "Envisioning the Agenda for Water Resources Research in the 21st Century". Henry, who is the former Director of the California Institute, will chair a new National Research Council panel to develop a more detailed and expanded research agenda and recommendations on how that agenda should be adopted and implemented.

Henry first noted the inadequacy of science to support water management today and then outlined the need for new knowledge and the corresponding need to augment the investment in water research to improve the science. He challenged the directors to take more responsibility for improving the science. Specific steps might include developing documentation of past accomplishments and assuming leadership roles in efforts to secure new investment in water research. He also noted that the institute directors and NIWR represent the only group that can provide coordinated entree to the scientific brainpower in the nation's Universities. Henry urged that they become more visible and active players on the national water research scene.

Robert Ward, Colorado Director, and Chuck Hennig, Bureau of Reclamation, look at the NAS Water Research Agenda report.

The national water institute program, as do many federally-funded water research programs, faces a daunting challenge in communicating the need for new knowledge and new investment in water research. The annual NIWR meeting, by providing an excellent forum for discussion, assists in defining the challenges and organizing universities to address them.

For more information on NIWR, please refer to its homepage located at New Mexico State University (noted above) or refer to the new online program management system used to manage the water research institute programs at http://www.niwr.org/NIWR/. This innovative water research administration software system provides considerable efficiency and high levels of communication capabilities among the 54 water institutes.

Robert Ward, as NIWR President-Elect, organized this year's NIWR meeting with the assistance of Emile Hall, CSU Graduate Student in Watershed Science, who served as meeting coordinator.

ECONOMICS OF THE OGALLALA: 2002 OGALLALA SYMPOSIUM HELD IN STERLING

by Joel Schneekloth

The 2002 Ogallala Aquifer Symposium was held at the Northeast Junior College in Sterling, Colorado on February 21, 2002. The theme for this year's symposium was "The Economics of the Ogallala." Total attendance at the event was 230 people from the three-state region of Colorado, Kansas and Nebraska. Overall, comments about the symposium and interaction among the people who attended were very positive.

The symposium was highlighted by presentations on the Republican River Litigation. Hal Simpson, Colorado State Engineer, gave a history of the Republican River Compact and updated the audience on current litigation. The three states currently are negotiating a settlement, trying to prevent a trial. Matt Landon, with the United States

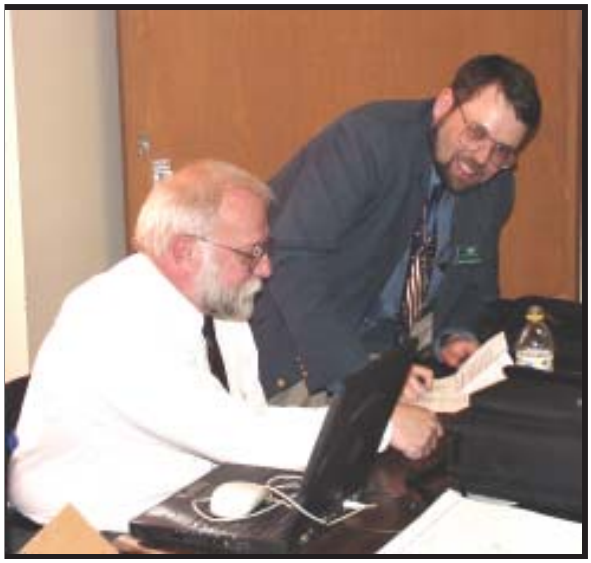
Randy Ristau, Colorado Department of Health, and Gisele Jefferson, Golden Plains Area Extension, exchange pleasantries.

Geological Survey, presented the current findings of a large-scale water model for the Republican River Basin. Matt looked at the impacts of conservation practices (such as no-till, terraces and others) and irrigation upon the stream flows of tributaries on the Republican River. Currently, conservation practices are having a significant impact upon the flows

Troy Bauder, CSU, and Pete McMahon, U.S. Geological Survey, Denver, exchange ideas at the symposium exhibit.

by reducing runoff from fields and preventing that water from reaching the stream.

Other topics at the symposium included "Current Colorado Water Issues," Rural Community Water Issues, Managing Your Water and Nutrients, Water – Ogallala's Gold, and The Hydrology of the Ogallala Aquifer.



Joel Schneekloth helps Bob Hipple, Upper Republican Natural Resources District, with his presentation.

HYDROLOGY OF THE OGALLALA AQUIFER

presented by Jim Goeke, University of Nebraska-Lincoln

Jim Goeke spoke during the General Session that opened the symposium on "The Hydrology of the Ogallala Aquifer." Jim is a professor and research hydrogeologist with the University of Nebraska at Lincoln, Institute of Agriculture and Natural Resources (UNL-IANR Conservation and Survey Division), and has been stationed at the West Central Research and Extension Center at North Platte, Nebraska since 1976. He has worked on regional water studies in southwest and south central Nebraska with federal, state and local agencies, municipalities and individuals to identify, monitor, and manage ground water problems. Summarized below are some of Jim's comments from his presentation.

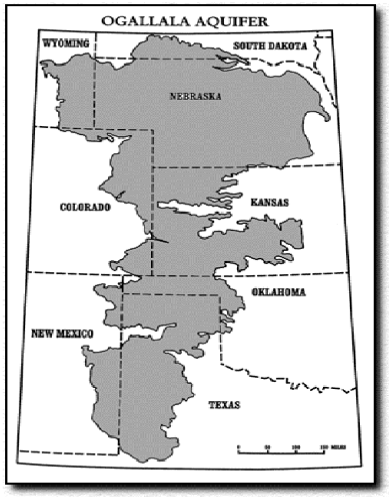


Figure 1: Area covered by the Ogallala Aquifer. Courtesy of High Plains Underground Water Conservation District No.1.

The Ogallala Aquifer water resource is critical to the future of the High Plains. The aquifer has been accumulating for almost 20 million years, and in 1980 contained an estimated 3-1/4 billion acre-feet of recoverable water. Its specific-yield average might be about 18 to 20 percent drainable water available for use. Of this 3-1/4 billion acre-feet of water, Nebraska had 66 percent, Kansas 10 percent, Texas 12 percent, Colorado 4 percent, and the remaining 8 percent was divided among Oklahoma, South Dakota, New Mexico and Wyoming.

Table 2. Average area-weighted water-level changes in the High Plains aquifer, predevelopment to 1980, to 1999, and 1998 to 1999.

State	Average area-weighted water-level change			
	Predevelopment (1950) to 1980		1980 to 1999	1998 to 1999
	Water-level change[1] (ft)	Rate of change (ft/yr)	Water-level change (ft)	Water-level change (ft)
Colorado	-4.2	-0.14	-6.2	-0.24
Kansas	-9.9	-0.33	-8.4	-0.39
Nebraska	0	0	2.6	0.49
New Mexico	-9.8	-0.33	-5.1	-1.03
Oklahoma	-11.3	-0.38	-4.6	-0.57
So. Dakota	0	0	3.1	1.01
Texas	-33.7	-1.12	-8.9	-1.49
Wyoming	0	0	-3.2	-0.15
High Plains	**-9.9**	**-0.33**	**-3.2**	**-0.25**

[1]Luckey and others (1981).

Twenty percent of the irrigated acreage in the United States is in the eight-state area of the High Plains Aquifer. Thirty percent of U.S. ground water pumped is in this area. In 1980, 170,000 irrigation wells pumped 18 million acre-feet of water to irrigate 14 million acres. Precipitation varies from 28 to 30 inches on the east side of the aquifer down to 16 inches or less on the west end. That is a greater variation in climate across the aquifer than exists f rom the Missouri River to the Atlantic Ocean.

A U.S. Geological Survey Fact Sheet available to symposium participants (USGS FS-029-01, March 2001) shows that water-level declines occurred in the High Plains Aquifer soon after the beginning of extensive ground water irrigation development. The declines occur because of an imbalance between discharge, the largest component of which is ground water withdrawals for irrigation, and recharge, which is primarily from precipitation. The pattern of water level changes in the High Plains aquifer from predevelopment, 1980 to 1999, and 1998 to 1999 is shown in the following table (Table 2, USGS FS-029-01, March 2001).

How one deals with the High Plains Aquifer depends upon his or her perspective and where one is located n the system. Water systems such as the Ogallala are very complex, and require an understanding of all the parameters including evaporation, transpiration, infiltration, circulation, and movement of these water resources. Nature likes a balance between recharge and discharge, but wells can be drilled and seriously affect the distribution and impact of that recharge.

How much does rainfall replenish the ground water supply? This is a crucial factor, and the estimates are from 4-5 inches in Nebraska down to 0.25 inch in Texas. On average, about 10 percent of annual rainfall might recharge a ground water aquifer, and the estimate can be doubled in coarse-textured, sandy soils. In a departure from normal, from 1981 to 1993 rainfall was as much as 5 inches above normal in some areas. This is fortunate, but cannot be expected to continue.

A question from the audience: "Do any municipal water supplies come from the Ogallala?" Answer from Jim: Most Nebraska municipalities depend on ground water for their supplies – Omaha and Lincoln, the primary population centers, are on the east side of the aquifer and take their water from wells along the Platte Valley. The tie to the High Plains Aquifer is that the water that comes out of the sand hills in the Loup River Basin and the Elkhorn River Basin flows into the Platte east of Columbus.. Since records have been kept, the Platte has never gone dry east of Columbus because ground water supports the flow of streams that drain from this area of high infiltration rates. Yet, west of the Columbus the Platte has often gone dry. So, although Omaha and Lincoln are not directly in the High Plains Aquifer, their water supplies depend on discharge from this aquifer.

UPDATE ON WATER LEVELS IN THE OGALLALA AQUIFER

Source: Ground Water Levels, Northern High Plains Designated Ground Water Basin, 2002, by George D. VanSlyke, Division of Water Resources. Copies are available through the Office of the State Engineer, 1313 Sherman St., Room 821, Denver, CO 80203.

Colorado

Annual results of well-water levels measured during the winter of 2000-2001 indicate a continued decline in water storage levels throughout the Northern High Plains Designated Basin. No surprise when mining a non-renewable resource. At almost three times the rate of the previous year, last year's diminishing results produced an average rate three times the ten-year average. The rapid acceleration was attributed to the dry year. According to the 2001 report from the Colorado Division of Water Resources, the Northern High Plains Designated Basin level dropped 1.57 feet overall in 2000-2001, compared to the 1999-2000 descent of .51 feet. Based on previous studies, a 1-foot drop represents a depletion of approximately 900,000 acre-feet. Consequently, the latest water-level reduction of 1.57 feet indicates that roughly 1,413,000 acre-feet of water have been removed from the aquifer.

The water basin level has sunk nearly 3.33 feet over the past five years, which is approximately 3,000,000 acre-feet, or three percent of the total water storage volume as estimated in 1965. The depletion over the last 10 years, measured by a decline of 5.76 feet, indicates that over 5,000,000 acre-feet have been removed from the aquifer at a rate of one-half percent per year. This 10-year average rate indicates the basin is being depleted at the rate of 50 percent in 100 years, exceeding its revised 1990 allowable designation rate of 40 percent over 100 years.

Groundwater Levels in Other High Plains States

For information about groundwater levels in other High Plains states see the following websites:

Nebraska	**http://www.nrc.state.ne.us/databank/gwlevels/textdoc.htm**
Kansas	**http://magellan.kgs.ukans.edu/WaterLevels/CD/index.htm**
Texas	**http://www.hpwd.com/news/newsroom/story.asp?qsNewsID=14**
Oklahoma	**http://www.owrb.state.ok.us/reports/high_plains.pdf**
New Mexico	**http://www.nm.water.usgs.gov and www.wrri.nmsu.edu**
Wyoming	**http://www.wy.water.usgs.gov and http://waterplan.state.wy.us/**
South Dakota	**http://wwwsd.cr.usgs.gov**

NEW FACULTY PROFILE

JOEL SCHNEEKLOTH
REGIONAL EXTENSION SPECIALIST IN WATER RESOURCES

Joel Schneekloth is the new Regional Extension Specialist in Water Resources for Northeast Colorado. Joel is based in Akron at the U.S. Central Great Plains Research Station. He comes to Colorado from Nebraska where he worked in research and extension for nine years, with a focus on the impacts of crop rotation on limited water supply and water quality.

In Northeastern Colorado, water is an important commodity and a coveted resource. "There are many issues affecting water within the region," says Joel. "Legal issues such as the Republican River Litigation and the Endangered Species Act can have a major impact on the amount of water available and the economic viability of the region. Other issues are water supply, with the South Platte River snowpack-fed and being variable from year to year, and declining water supplies in the Ogallala Aquifer."

To address these issues, Joel will use applied research and demonstrations related to water supply management. "Water conservation is important in today's society," says Joel. "It is important for preserving the resource, but also from an economic standpoint. The pieces to the conservation puzzle are out there, and we just need to put them together in a package that will work for producers."

A large part of Joel's program involves educational opportunities for people interested in water. "People within the water community need to know what the issues are, the consequences of those issues, and what the potential solutions are," he says. "Water and agriculture have always been a part of my life, and I am committed to providing assistance that will give people knowledge in those areas and help solve the issues related to water."

Joel can be contacted at:

U.S. Central Great Plains Research Station
40335 CR GG
Akron, Colorado 80720

Phone: 970/345-0508
Fax: 970/345-2088
Email: Joel.Schneekloth@Colostate.Edu

THREE BID FOR ENRON'S WESSEX WATER

Mon Mar 4, LONDON - Companies from Hong Kong and Malaysia and a consortium that includes two major British banks and the General Electric Co. are bidding for Wessex Water, a utility owned by Enron Corp. Competing bids came from Cheung Kong Infrastucture Holdings of Hong Kong and the Malaysian energy group YTL. The bids were submitted to PricewaterhouseCoopers, the administrator for Enron Europe. Wessex Water, one of Enron's largest European holdings, provides water to 1.2 million people in 513,000 households across southwestern England, and sewage service to about 2.5 million people in the same area. Gillian Winstone, a spokeswoman for Wessex Water, would not comment on the progress of the sale, saying any decision would be subject to approval by regulators. The Italian energy company Enel said last week it was withdrawing from the sale. Houston-based Enron bought the water company for $2.2 billion in 1998. The purchase was the cornerstone for Enron's Azurix water unit, whose lofty ambitions of massive profits crashed, leaving it with enormous debt. (Source: Associated Press via Yahoo! News.)

CWRRI CU WATER NEWS

NATURAL RESOURCES LAW CENTER *hot topics!*

University of Colorado School of Law

Allocating and Managing Water for a Sustainable Future: Lessons from Around the World

23rd Summer Conference, June 11-14, 2002

Fleming Law Building, Boulder, Colorado

Purpose: The purpose of the conference is to examine innovative water allocation laws, policies and institutions from around the world that provide lessons for sustainable water management. In keeping with the Center's focus on natural resources issues of the Western United States, the conference will focus its attention on problems applicable to the American West. Sessions will focus on innovative legal and institutional developments and lessons that can be transferred across different regions, countries, cultures, economies, and water systems. The lessons will provide examples from a variety of geographic scales, ranging from international rivers to irrigation systems and watershed management. International speakers and case studies will be drawn from world regions that share the American West's challenges of managing uncertain and variable water supplies. The theme of the conference is adapting for sustainability — how the design of Western water law and policy and the management of water resources can be ecologically and economically sustainable. **See the Natural Resources Law Center Web Site at http://www.colorado.edu/Law/NRLC/2002Conference.html**

hot topics!

May 20th -- Non-Federal Hydropower Re-licensing

All "Hot Topics" are offered from noon-1:30 at Holland & Hart Law Offices, 555 – 17th St. Ste. 2900, Denver, Colorado. Main Phone No.: 303/295-8000. Each earns one CLE credit.

Environmental, Population, and Organismic Biology Colloquium Series

Spring 2002 Colloquium Schedule

Note: All sessions meet in the conference room of building IBS # 3 (second building north on Broadway from Starbucks' Coffee) on Mondays, from 12:00 to 1:30.

*April 30: Professor **Paul Mohai** of the University of Michigan's School of Natural Resources will speak on " Spatial and Temporal Analyses Applied to Understanding Racial Socioeconomic Disparities in the Location of Environmental Hazards."
*Note that this session, which is joint with Sociology, meets on Tuesday , 12:30-2:00. Site will be announced later.

See the EPOB Web Site at: http://www.colorado.edu/epob/events/colloq.html

Chuck Howe is Senior Editor of New Water Publication

Chuck Howe is the Series Editor of the newly published "Management of Water Resources Series," consisting of five volumes published by Edward Elgar Publishers of Cheltenham, U.K.. The highly integrated series of volumes consists of (1) "Irrigated Agriculture and the Environment," edited by James Shortle of Penn State and Ronald Griffin of Texas A&M; (2) " Water Resources and Climate Change," edited by Kenneth Frederick of Resources for the Future; (3) "Water Resources and Economic Development," edited by R. Maria Saleth of the Institute for Social and Economic Change, Bangalore, India; (4) "The Economics of Industrial Water Use," edited by Steven Renzetti of Brock University, Canada; and (5) "Conflict Prevention and Resolution in Water Systems," edited by Aaron Wolf of Oregon State University.. The intent of the series is to make available to newer institutions and agencies the key literature in each of the areas noted above in light of the broad national and international attention being paid to water resources and related problems. Chuck Howe is Professor of Economics and a member of the Professional Staff, Environment and Behavior Program, Institute of Behavioral Science, University of Colorado at Boulder, phone: (303) 492-7245; fax: (303) 492-1231.

CSM WATER NEWS

igwmc

International Ground Water Modeling Center 2002 Short Course Schedule

Colorado School of Mines, Golden, Colorado, 80401-1887, USA
Telephone: (303) 273-3103; Fax: (303) 384-2037; E-mail: igwmc@mines.edu; URL: http//www.mines.edu/igwmc/

POLISHING YOUR GROUND WATER MODELING SKILLS
May 7 -10, 2002 — Instructors : Dr. Peter Andersen and Dr. Robert Greenwald

This course is designed to provide significant detail on practical ground water flow modeling concepts and techniques. It will explore development of conceptual models for complex sites or regions, how to convert these conceptual models to appropriate ground water flow models, and how to apply supplemental MODFLOW modules to effectively solve such problems. This course takes the user beyond topics covered in introductory modeling courses and beyond courses that teach the mechanics of applying various pre- and post-processing software.

APPLIED ENVIRONMENTAL STATISTICS
In California – June 10 -14, 2002; In Colorado – August 12 -16, 2002
Instructors : Dr. Dennis Helsel and Dr. Ed Gilroy

This five day course develops hands on expertise for all environmental scientists who interpret data and present their findings to others. The course emphasizes: when each statistical method is appropriate; plotting and presenting data; assumptions and implications behind statistical tests; how to build a good regression model, and trend analysis with common pitfalls. Our Goal: for you to make sense of your data.

PRACTICAL SIMULATION OF VARIABLE-DENSITY FLOW, SOLUTE TRANSPORT, AND SEAWATER INTRUSION
October 21 - 25, 2002 — Instructors : Dr. Clifford I. Voss and Dr. Craig T. Simmons

The aim of this course is to familiarize attendees with:1) the basics of solute transport processes for both constant and variable-density flow, 2) numerical aspects of simulating constant and variable-density flow with solute transport, 3) setting up, running, post-processing and evaluating flow and transport models, and 4) practical aspects of transport modeling and case studies. Attendees will learn to run a variable-density flow and solute transport simulator (U.S. Geological Survey's SUTRA code) using a graphical interface.

MODFLOW: INTRODUCTION TO NUMERICAL MODELING
October 23 - 26, 2002 — Instructor : Eileen Poeter

This course is designed for the hydrogeologist and environmental engineer familiar with ground water flow concepts, but who have limited or no experience with ground water flow modeling. Basic modeling concepts: conceptual model development, definition of boundary and initial conditions, parameter specification, finite-differencing, gridding, time stepping, and solution control using MODFLOW-2000 and UCODE. Basic modules of MODFLOW are explained and concepts are reinforced with hands-on exercises. Calibration is presented via the public domain universal inversion code, UCODE.

UCODE: UNIVERSAL INVERSION CODE FOR AUTOMATED CALIBRATION
October 25 - 26, 2002 — Instructor : Eileen Poeter

If you have a working knowledge of ground water flow modeling and some knowledge of basic statistics, you will benefit the most from this short course. This course introduces ground water professionals to inverse modeling concepts and their use via UCODE, relying heavily on hands-on exercises for automatic calibration of ground water models to promote understanding of UCODE and avoid "black-boxing."

FOR INFORMATION CALL (303) 273-3103 FOR REGISTRATION CALL (303) 273-3321
VISIT http://www.mines.edu/research/igwmc/short-course/

UPCOMING CONFERENCE
The International Conference ModelCARE 2002
4th International Conference on CALIBRATION AND RELIABILITY IN GROUNDWATER MODELING:
A few steps closer to reality
Prague, Czech Republic, 17-20 June 2002

See the IGWC web site at the address above

UNC WATER NEWS

COLORADO SUMMER 2002
Graduate Field Science Courses
at the University of Northern Colorado
FEATURING COURSES IN ROCKY MOUNTAIN NATIONAL PARK
AND DINOSAUR NATIONAL MONUMENT

ESCI 584-521 "ALPINE MICROMETEOROLOGY" (2 cr.) M. Taber 7 am-6 pm WED., THURS., FRI., SAT. McKee 138 and field trips (including overnights) 6/12-15/02

The purpose of this course is to provide students with an opportunity to engage in authentic research in micrometeorology. This course will consist of a four-day field experience in Rocky Mountain National Park and western slope locations. Data analysis and completion of project will take place during unscheduled time in consultation with instructor. The first day will orientate students with the study of micrometeorology and instrumentation, providing students with enough background to engage in field research. Students will work in teams of three during the four-day field experience. Each team will choose a topic to investigate, often collaborating with other teams in a "system" approach to problem-solving. Topics may include energy balance and calculating budgets, horizontal and vertical heat transfer, boundary layer fluxes, instrumentation, soil heat flux, evapotranspiration, field photosynthesis and respiration, effects of climate change on animals and plants, and adaptation/acclimatization. Students will be expected to produce results that are suitable for publication. Program fee ($275) covers course materials (excluding text), meals, lodging, and transportation during the field experience. Students are expected to provide personal items and lunch the last day of field experience. **Prerequisites** include: a basic meteorology course, equivalent experience, or consent of instructor, ESCI 584-502 "Meteorological Instrumentation"—see below (Offered June 10 and 11, 2002 on the UNC campus by Dr. Taber), and first semester calculus. For more information and to obtain the required application form, please contact Dr. Michael Taber (970) 351-2470, e-mail mrtaber@unco.edu, Department of Earth Sciences, Campus Box 100, University of Northern Colorado, Greeley, CO 80639.

ESCI 584-502 "METEOROLOGICAL INSTRUMENTS" (1 cr.) M. Taber 8 am-5 pm MON. & TUES. McKee Hall 223 6/10-11/02. **PRIMARILY OFFERED ON THE GREELEY CAMPUS!**

The purpose of this course is to provide students with a hands- on opportunity in the use of instrumentation for the study of meteorology. The contents of this course will be delivered over two days at the University of Northern Colorado. Students will learn how to set up and program instruments for collecting temperature, radiation, humidity, wind speed and wind direction data. In addition, students will be given an opportunity to interpret collected data for analysis. Students are expected to provide personal items, such as sunscreen protection, and lunch during the two–day class. **Prerequisites** are a basic meteorology course, equivalent experience, or consent of instructor, and a basic understanding of computers, including the use of spreadsheets. For more information please contact Dr. Michael Taber (970) 351-2470, e-mail mrtaber@unco.edu), Department of Earth Sciences, Campus Box 100, University of Northern Colorado, Greeley, CO 80639.

ESCI 584-532 "ROCKS, REPTILES AND RAPIDS OF THE DINOSAUR NATIONAL MONUMENT AREA" (4 cr.) J. Morrow, L. Shropshire 8 AM-6 PM MON.-SUN. of one week and MON.-FRI. of the next week McKee Hall 139 6/17-28/02

Two-day on-campus workshop followed by ten-day field excursion which features a five-day raft trip down the stunningly beautiful and geologically spectacular Yampa and Green River canyons in Dinosaur National Monument. Although the focus of the course is the geology and paleontology of Dinosaur National Monument, it includes visits to other important localities in northwestern Colorado and northeastern Utah. Course project required. Prerequisite is one introductory geology course or equivalent experience. No previous rafting experience is necessary. This is a camping trip, and participants must provide their own tents, sleeping bags, and other personal items. Transportation to the field area is by UNC vans. Field trip fee of $920 is for meals and transportation during the trip, course materials, one night's lodging in Vernal, Utah, campground and entrance fees, and all equipment and services of the Holiday River Expeditions Company. Participants must fill out an application form and gain consent of instructor. For more information and an application form, contact Dr. Jared Morrow, Department of Earth Sciences, Campus Box 100, University of Northern Colorado, Greeley, CO 80639. Phone: 351-2483; e-mail: jrmorro@unco.edu.

RESEARCH AWARDS

A summary of research awards and projects is given below for those who would like to contact investigators. Direct inquiries to investigators c/o indicated department and university. The list includes new projects and supplements to existing awards. The new projects are highlighted in bold type.

COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO
Awards for January-February, 2002

TITLE	P.I.	DEPT.	SPONSOR
Fire, Runoff, and Erosion in Forested Areas: Prediction and Validation	Macdonald, Lee	Earth Res.	USFS
Midlatitude Mesoscale Convective Systems	Johnson, Richard	Atmos. Sci.	NSF
Use of Tropical Rain Measuring Mission Data to Test an Improved Parameterization of Stratiform Precipitation	Randall, David	Atmos. Sci.	NASA
Analysis of Data from Tropical Rainfall Measuring Mission …	Rutledge, Steven	Atmos. Sci.	NASA
National Parks Vital Sign Project	Binkley, Daniel	NREL	Nat'l. Parks & Conserv.Assn.
Research & Education Activities to Enhance Water Management & Conservation in Southwest Colorado	Berrada, Abdelfettah	SW CO Res Ctr	USBR
Framework for Decision Support System for Rocky Flats	Garcia, Luis	Civil Engr.	DOE
Inventory & Monitoring Natural Resource Status & Trends in the National Park Systems	Hannah, Judith	Earth Res.	NPS
Riparian Vegetation Studies on the Green & Yampa Rivers	Cooper, David	Earth Res.	USBR
Identification, Public Awareness, & Solution of Waterlogging & Salinity in the Arkansas River Valley	Gates, Timothy	Civil Engr.	USBR
Key to Larval Native Fishes	**Bestgen, Kevin**	**FWB**	**USBR**
Developing a Decision Support System for the South Platte Basin	Ward, Robert	CWRRI	Various "Non-Profit"
CG/AR Advanced Hydrological Modeling	**Ramirez, Jorge**	**Civil Engr.**	**DOD**
Development & Evaluation of Fishery Management Options for the Control of Salmonid Whirling Disease	Bergersen, Eric	Coop Fish & Wildlife Res.	USGS
A Modeling & Remote Sensing Study of the Radiative Heating of Clouds in Support of ARM	Stephens, Graeme	Atmos. Sci.	DOE

FEDERAL SPONSORS: BLM-Bureau of Land Management, COE-Corps of Engineers, DOA-Dept. of the Army, DOD-Dept. of Defense, DOE-Dept. of Energy, DON-Dept. of the Navy, DOT-Dept. of Transportation, EPA-Environmental Protection Agency, HHS-PHS-Public Health Service, NASA-National Aeronautics & Space Administration, NBS-National Biological Survey, NOAA-National Oceanic & Atmospheric Admin., NPS-National Park Service, NRCS-Natural Resources Conservation Service, NSF-National Science Foundation, , USAID-US Agency for International Development, USBR-US Bureau of Reclamation, USDA/ARS-Dept. of Agriculture, Agricultural Research Service, USDA/NRS-Dept. of Agriculture, Natural Resources Service, USFS-US Forest Service, USDA-USFS-RMRS-Rocky Mountain Research Station, USFWS-US Fish & Wildlife Service.

STATE/LOCAL SPONSORS: CDA-Colorado Department of Agriculture, CDNR-Colorado Dept. of Natural Resources, CDPHE-Colorado Dept. of Public Health and the Environment, CDWL-Colorado Division of Wildlife, NCWCD-Northern Colorado Water Conservancy District. OTHER SPONSORS: AWWA-American Water Works Assn., CID-Consortium for International Development.

UNIVERSITY DEPARTMENTS, INSTITUTES AND CENTERS: Colorado State: BSPM-Bioagricultural Sciences & Pest Management, CBE-Chemical & Bioresource Engr., CSMTE-Center For Science, Mathematics & Technical Education, CIRA-Cooperative Inst. for Research in the Atmosphere, DARE-Dept. of Agric. & Resource Economics, FWB-Fishery & Wildlife Biology, HLA-Horticulture & Landscape Architecture, NREL-Natural Resource Ecology Lab, NRRT-Nat. Resources Recreation & Tourism, RES-Rangeland Ecosystem Science, SCS-Soil & Crop Sciences. University of Colorado: ACAR-Aero-Colorado Center for Astrodynamic Research, AOS-Atmospheric & Oceanic Sciences, CADSWES-Center for Advanced Decision Support for Water and Environmental Systems, CEAE-Civil, Environmental, and Architectural Engineering, CIRES-Cooperative Institute for Research in Environmental Sciences, EPOB-Environmental, Population & Organismic Biology, IAAR-Institute for Arctic & Alpine Research, IBS-Institute of Behavioral Science, ITP-Interdisciplinary Telecommunication Program, LASP-Lab. For Atmos. And Space Physics, PAOS-Program in Atmospheric and Oceanic Sciences

TITLE	P.I.	DEPT.	SPONSOR
ARM Carbon Modeling & Land Surface-Atmosphere Model Applications	**Hanan, Niall**	**NREL**	**Univ. of Tenn.**
Advanced Hydrometeor Identification of Severe Storms During STEPS (Severe Thunderstorms, Electrification &…	Bringi, Viswanathan	Elec. & Comp. Engr.	NSF
Arkansas River Water Quality	**Clements, William**	**FWB**	**CDWL**
Use of ARM Data to address the Climate Change Problem	Randall, David	Atmos. Sci.	DOE
Interactions of the Monsoons & Anticyclones in the Coupled Atmosphere-Ocean System	Randall, David	CIRA	NOAA
Enhancement of Satellite Data Processing & Analysis Capabilities in Central America	Vonderhaar, Thomas	CIRA	NOAA
Air-Sea Interaction Remote Sensing Processes	Vonderhaar, Thomas	CIRA	NOAA
Environmental Applications Research Project	Vonderhaar, Thomas	CIRA	NOAA
Coupling between Monsoon Convection & Subtropical Highs in the PACS Region on Subseasonal to Interannual Time Scales	Johnson, Richard	CIRA	NOAA
Enhanced Communications at CIRA for the Development of Real-time Evaluation of Advanced Microwave Sounder …	Vonderhaar, Thomas	CIRA	NOAA
CIRA Activities & Participation in the GOES I-M Product Assurance Plan	**Vonderhaar, Thomas**	**CIRA**	**NOAA**
Research for Mitigation for Lost Production of Naturally Reproducing Salmonids in the Sacramento River	Fausch, Kurt	FWB	USBR
Tamarisk Removal & Riparian Restoration Along Reaches of the Green River, Colorado	Cooper, David	Earth Res.	USBR
Mississippi River Dikes, Phase 3	**Watson, Chester**	**Civil Engr.**	**USFS**
Exploration of the Ethical Basis for Agricultural Sustainability	**Zimdahl, Robert**	**BSPM**	**Utah State Univ.**
Risk Mitigation Studies for Evolving Data & Information Systems Related to Rainfall Missions	**Kummerow, Christian**	**Atmos. Sci.**	**NASA**
Herbivory in Streams - Context-Dependent Species Interactions & Functional Redundancy…	Poff, N. Leroy	Biology	NSF
Willow Persistence in Yellowstone National Park: Interactive Effects of Climate, Hydrology & Herbivory	Hobbs, N. Thompson	NREL	USGS
Evaluation of Effects of Stage Fluctuations Induced by Hydropower Operations on Over-winter Survival	**Beyers, Daniel**	**FWB**	**USBR**
Identification & Curation of Larval Fish by Colorado State University Larval Fish Laboratory	**Snyder, Darrel**	**FWB**	**USBR**
Abundance Estimates for Colorado Pikeminnow in the Middle Green & Yampa River Systems	**Bestgen, Kevin**	**FWB**	**USBR**
Evaluation of Larval Razorback Sucker Drift into Flood Plain Wetlands Following Reconfiguration of Levee Breaches	Bestgen, Kevin	FWB	USBR
Verification of Stocked Razorback Sucker Reproduction in the Gunnison River via Annual Collections of Larvae	Bestgen, Kevin	FWB	USBR
Population Estimates of Colorado Pikeminnow in the Lower Green River	Bestgen, Kevin	FWB	USBR

DUE DILIGENCE REQUIREMENTS

The owner of a conditional water right is required to file, during the same month every 6 years, an application for a finding of reasonable diligence in the Waster Court of the Division in which the water right exists, proving that he or she has been diligently pursuing completion of the project necessary to apply the water involved to a beneficial use. Should a person fail to show diligence in the courts, the right itself can be deemed abandoned. *Colorado Water Conservation Board, Colorado River Basin Basic Facts.*

UNIVERSITY OF COLORADO, BOULDER, COLORADO 80309
Awards for January 30 to March 26, 2002

TITLE	P.I.	DEPT.	SPONSOR
ICESAT Mission Operations Delta Costs for the New Nominal Program	**Davis, Randal**	**LASP**	**Ball Aerospace**
Validation Studies and Sensitivity Analysis for Retrievals of Snow Albedo and Snow-Covered Area from EOS AM-1 Instruments	Nolin, Anne	CIRES	NASA
Decision Support for Design-Build Delivery of Water/Wastewater Treatment Facilities Phase One…	**Molenaar, Keith**	**CEAE**	**Black & Veatch**
Standard Global Snow Cover Products from Satellite Remote Sensing	Armstrong, Richard	CIRES	NASA
A Regional, Integrated Monitoring System for the Hydrology of the Pan-Arctic Land Mass	Serreze, Mark	CIRES	NASA
Global Land Ice Measurements from Space	Scharfen, Gregory	CIRES	NASA
Ice Shelves and Landfast Ice on the Antarctic Perimeter: Characteristics and the Effects of Climate Change Determined by Analysis of SAR, SMM/I, and AVHRR Data	Scambos, Theodore	CIRES	NASA
Radiation Climatology of the Greenland Ice Sheet Derived from Greenland Climate Network Data	**Steffen, Konrad**	**CIRES**	**NASA**
Sediment Flux to the Coastal Zone: Predictions for the Navy	Syvitski, James	IAAR	DOD
Seabed Variability and its Influence on Acoustic Prediction Uncertainty	Syvitski, James	IAAR	DOD
Merging Infrared Sea Surface Temperature with Satellite Altimetry to Map Ocean Currents in Two Coastal Domains	Emery, William	ACAR	Jet Propulsion Lab
Analysis of Airborne Data for Validation of CLOUDSAT Ice Cloud Measurements	Evans, K. Franklin	PAOS	Jet Propulsion Lab
An Integrated Assessment of the Impacts of Climate Variability on the Alaskan North Slope Coastal Region	Syvitski, James	IAAR	NSF
Paleoglaciology of Alaska -- Climate Parameters During the Last Glacial Maximum from GIS Determination of Equilibrium Line Altitudes	Manley, William	IAAR	NSF
Archive and Data Distribution System for Glaciological and Cryospheric System Data from the U.S. Antarctic Program…	Scharfen, Gregory	CIRES	NSF
Climate Modeling and Societal Impacts: Scientific, Political, and Philosophic Themes	Frodeman, Robert	CIRES	NSF
The Mechanics of Rock Glacier Creep: A New GIS Method and Possible Response to Climate Change	**Caine, T. Nelson**	**Geography**	**NSF**
The Effects of Climate and Disturbance Variation on Post-Fire Regeneration of Madrean Pine-Oak Forests in Mexico's Sierra Madre Occidental	**Veblen, Thomas**	**Geography**	**NSF**
Toward a Realistic Estimate of Sea-Level Rise and Global Water Balance due to Glacier Wastage	Dyurgerov, Mark	IAAR	NSF
Climatological Studies with Doppler Radar	Mapes, Brian	CIRES	NSF
Characterization of Atmospheric Moisture Transport and the Freshwater Budget of the Arctic with an Improved Regional Model	**Serreze, Mark**	**CIRES**	**NSF**
A Study of the Spatial and Temporal Transitions of Climate and Ecosystems in the Circumpolar Arctic	Lynch, Amanda	CIRES	NSF
Variability and Forcing of Climatic Parameters on the Greenland Ice Sheet: Greenland Climate Network (GC-NET)	Steffen, Konrad	CIRES	NASA
Predictability of the Coupled Ocean-Atmosphere System on Intraseasonal and Interannual Time Scales: Emphasis on the Monsoon and Enso and Their Interaction	Webster, Peter	PAOS	NOAA

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Contact the U.S. Geological Survey, Box 25046, MS415, Denver Federal Center, Lakewood, CO 80225. Phone 1-888-ASK-USGS or 303/202-4700 (unless another source is provided). Website: **http://webserver.cr.usgs.gov**.

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WATER NEWS DIGEST

by Marian Flanagan

DROUGHT

Tree rings show proof of half-century droughts

Tree rings in centuries-old chunks of wood found in the Four Corners region show evidence of droughts that lasted as long as 50 years. Rings show a tree's annual growth, which reflects the amount of precipitation the area received for a given year. Evidence indicates most severe droughts in the Mesa Verde area spanned 1130 to 1180, when annual precipitation fell below 13.8 inches a dozen times. Droughts of five, 10, 15 and even 20 years dot the 11th, 12th and 13th centuries — all of which help researchers track the migrations of the ancestral Puebloans, who farmed the area successfully for 700 years. Eventually, they abandoned the Four Corners region. Nowadays, a drought of five years could seriously strain Colorado's water supply. Most of the state's large cities, Grand Junction and Denver included, are prepared for droughts while roughly 67 percent of Colorado's municipalities lack a backup plan.

The Grand Junction Daily Sentinel, 3/17/02; *The Montrose Daily Press*, 3/1/02

FLOOD

County readying flood handbook

County officials have mailed a 48-page "Flood Protection Handbook" to about 5,200 residents who live in the Boulder County area's major flood plains in preparation for unpredictable March-April weather. The manual describes what to do in case of a flash flood warning, how people can prepare a flood response plan and how to flood-proof a home or business. About 10,000 copies of the handbook were printed at a cost of $10,000, paid for with money from Boulder County, the city of Boulder and the Urban Drainage and Flood Control District. Any county resident can request a copy of the manual by calling the Boulder County Transportation Department at (303) 441-3900. The flood manual will be available on the county's Web site: www.co.boulder.co.us.

The Boulder Daily Camera, 2/2/02

FOREST/RIVER MANAGEMENT

Forest officials delay release of White River management plan

The final White River National Forest management plan is scheduled to be released in May, three months later than planned. A draft plan and environmental impact statement (EIS) to the White River's original 1984 plan was released in 1998, followed by a 9-month public comment period. Some 66,000 comments were received from all 50 states and several foreign countries, and each one has to be responded to in the final plan. When the final plan and EIS are released, White River officials plan to release information to the public. Forest officials expect appeals and litigation once the final plan, EIS and record of decision from the regional forester is released.

The Grand Junction Daily Sentinel, 3/8/02

Groups oppose plan for forest restoration

A U.S. Forest Service (USFS) plan to cut old-growth timber in a 5,200-acre swath of Pike-San Isabel National Forest is being opposed by a coalition of conservation groups. The Land and Water Fund of the Rockies, the Wilderness Society and the Upper Arkansas and South Platte Project have filed an administrative appeal asking USFS to reconsider some of its methods. The groups contend the Upper South Platte Restoration Project, if carried out improperly, could prevent the region from becoming a federally designated wilderness area. The USFSsays after years of fire suppression the timber stands have become too dense and prescribed burns, thinning and logging must be carried out to protect Denver's water supply and prevent a catastrophic fire. The forest includes two areas hit by fires in recent years: the Buffalo Creek wildfire in 1996 and the Hi Meadows fire in 2000. The USFS plan calls for hundreds of trees, some as old as 200 years, to be cut down to restore the forest to natural conditions. USFS also wants to create dozens of five-acre openings in the forest, which opponents consider a form of clear-cutting. The appeal filed last week says the work must be done with more care and that the five-acre openings must be made smaller or else the region might not qualify as a wilderness area.

The Pueblo Chieftain, 3/11/02

GLOBAL WARMING

Antarctica ice streams expanding

A new study by California researchers has found that Antarctica'sce streams are expanding by 26.8 billion tons of ice per year. They speculate the thickening ice streams are repeating a pattern that occurred from 1650 to 1850 when the Earth went through the Little Ice Age. The mammoth west Antarctic ice sheet, which contains enough water to lift the world's sea levels by 20 feet, isn't melting. Instead, the

ice sheet is thickening and Antarctica is getting cooler. Another study, published in the journal Nature, found that air temperatures in Antarctica's polar desert valleys actually declined by 0.7 degrees from 1986 to 1999.

The Denver Post, 2/3/02

Can global warming thaw a frozen mind-set

Climate change over the last 130,000 years is written in ocean sediment cores, Greenland ice cores, and in pollen records from across Eurasia as well. Ocean currents seem to play a very big role in abrupt climate change. The Gulf Stream functions depend on factors like variations in temperature, salinity, and volume of water. Rapidly melting ice can slow or halt its functioning; in fact, a recent study shows that it is slowing down. Most of the slowdown has occurred in the last five years, which were among the hottest in the last 1000 years. Climate modelers at the UK's Hadley Center for Climate Prediction tell us that if present trends in CO_2 emissions continue, the consequences will include a major setback of tropical forests, an increase in the number of people flooded from 13 million to 94 million, an additional 290 million people at risk of malaria, and 3 billion people suffering from water shortages.

Aspen Daily News, 2/18/02

Higher sea-level rise predicted

Data from two University of Colorado researchers show an accelerated rate of ice melt of glaciers and ice caps since the late 1980s, and indicate potential increases in sea levels in the 21st century, even greater than originally predicted by the Intergovernmental Panel on Climate Change. Mark Meier and Mark Dyurgerov, both with CU's Institute for Arctic and Alpine Research, used ice-melt data from about 300 glaciers worldwide to come up with the new estimates. The intergovernmental panel had calculated that glacier melt could add between .16 foot and .36 foot to sea level in the 21st century. Meier's estimate, which he said is "conservative," is that glaciers will contribute .65 feet to sea level rise. Meier says ice loss has accelerated because glaciers are more sensitive to climate now than they used to be. Global warming has accentuated at high latitudes, causing problems such as rapid glacier wastage in Alaska, according to new data from scientists at the University of Alaska. Another major contributor to sea-level rise is the warming of the ocean, causing the water to expand. While many scientists call the glacier ice-melt a result of global warming, it is subject to debate. Dyurgerov said it is hard to tell whether the warming is natural or caused by human influences.

***Boulder Daily Camera*,** 2/17/02

State-sized ice shelf falls off Antarctica

A Rhode Island-sized section of the Antarctic ice shelf has fallen into the ocean, the largest single collapse since the southern ice shelves started retreating 30 years ago. Scientists used satellite pictures to watch the collapse, which took place over 35 days. Most scientists now agree that higher temperatures fracture ice shelves by forming pools of meltwater. The meltwater, heavier than the ice it sits upon, eventually acts as a wedge, splitting shelves apart. The temperature doesn't have to get warm enough to melt the entire shelf away; it only needs to rise enough to form ponds of meltwater, which will quickly destroy the shelves. According to Ted Scambos, a glaciologist at CU's National Snow and Ice Data Center, several other large ice shelves are only a few degrees away from forming the meltwater ponds that will eventually crack them.

The Denver Post, 3/19/02

INSTREAM FLOWS/RECREATION

Foes line up against city water bid

More than a dozen opponents have filed objections in Pueblo Water Court to the city of Pueblo's request for in-channel recreation water rights in the Arkansas River. The city's claim asks for a maximum river flow of 500 cfs in the downtown stretch of the river March-November to guarantee recreational water in the river for The Arkansas River Legacy Project.'s kayaking and boating course. Thirteen groups have filed formal objections in opposition, and nany argued that they have senior water rights. When the city filed its claim, it began a process whereby it must also make its case before the Colorado Water Conservation Board (CWCB) which will make a recommendation to the water court. Many of the objectors to Pueblo's claim for recreational rights will make their case to the CWCB as well. CWCB has been reluctant to acknowledge recreational water rights and has opposed the city of Golden's claim to similar rights on its river. That case is before the Colorado Supreme Court.

The Pueblo Chieftain, 3/2/02

Whitewater park gets county go-ahead

Five "drop" structures creating rapids and eddies for the enjoyment of recreational boaters - mostly kayakers - are being constructed in the Gunnison River immediately downstream of the Twin Bridges. The benefits of the park are varied. Kayakers, one of the country's fastest

growing sports demographic, love them. Gunnison High School teenagers will benefit from the park in high school's outdoor recreation program. Recreation is the second largest program, behind business, at Western State College. The park will be another great selling point for their program, as well.

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Gunnison Country Times, 3/7/02

Pitkin County joins Breck, kayakers, other groups in water-rights battle

The Colorado Supreme Court is being asked to consider whether cities and towns in Colorado should be allowed to control stream flows for rafters and kayakers. Pitkin County commissioners join more than 50 other government agencies in the case of the State Engineer and the Colorado Water Conservation Board (CWCB) versus The City of Golden. Earlier this year, Golden obtained control over spring and early summer stream flows in Clear Creek. Breckenridge, Vail and Aspen have applied for similar streamflow rights. Golden's application drew protests from a number of Front Range communities dependent on water diversion projects from the West Slope to support growth. It also drew opposition from the CWCB, which controls the right to set minimum streamflows. After the state water court ruled in favor of Golden earlier this year, the CWCB and the state engineer appealed to the Colorado Supreme Court. A number of Front Range communities filed briefs in support of the appeal.

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Summit Daily News, 3/5/02

PEOPLE

Whitman Names Robert E. Roberts To Head U.S. EPA Region 8

U.S. Environmental Protection Agency (EPA) Administrator Christine Todd Whitman has named Robert E. Roberts the new administrator of EPA Region 8, which encompasses Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming. Roberts will leave his post as executive director of the Environmental Council of States (ECOS; Washington, D.C.), which he has held for the last 7 years, to join the EPA. (ECOS is a national association of U.S. state and territorial environmental commissioners. Roberts was the organization's first executive director.) Roberts is a member of the National Environmental Policy Commission, established last year by the Congressional Black Caucus to address environmental justice, public health, and economic development issues. He also is former secretary of the South Dakota Department of Environment and Natural Resources, a post he held from 1990 to 1995. He holds a bachelor's degree from the University of Alabama (Tuscaloosa) and a master's degree from Auburn University (Auburn, Ala.).

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http://www.wef.org/Memberzone/wefreporter/index.jhtml WEF website

WATER LAW/WATER RIGHTS

Club 20 objects to water law changes

Club 20 says it would object to any major changes to state laws that regulate how much water should remain in the state's rivers. The stance serves as an objection to a bill in the Colorado Senate that would change the state's "use it or lose it" water-rights policy by allowing water-rights owners to leave some of their water in the state's rivers and streams. The group also declined to endorse the creation of a nonprofit organization that would function much like the land trusts throughout the state. The organization, the Colorado Water Trust, could help water-rights holders to sell a portion of their rights either permanently or temporarily to the state, to increase the water level in streams and rivers. Former state Sen. Tilman Bishop cautioned Club 20 against ruling out such a plan because many people moving into the state don't understand Colorado's water laws and wonder why they can't use the water that flows in the state's rivers. Bishop fears, if frustration builds, Colorado will see a move to change the (state) constitution.

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The Grand Junction Daily Sentinel, 3/9/02

Strategy crystallizing in Black Canyon quantification case

In Jan. 2001 the National Park Service (NPS) filed an application in court to quantify its water right for the Black Canyon. Its primary motive was to return the national treasure to a more natural state, which would include yearly scouring of vegetation and sediment from large spring water run-off. NPS and other federal officials indicated a willingness to work with water users in the Upper Gunnison Basin, but many of these users are not happy with the application as it currently exists. They argue that junior irrigation uses could be called out when the park is calling for peak flows that could reach or exceed 12,000 cubic feet per second (cfs). This most recent development is a result of a "stay of proceedings" that's been crafted by the Upper Gunnison River Water Conservancy District in conjunction with the Colorado Water Conservation Board, the Uncompahgre Valley Water Users' Association, Mt. Emmons Mining, the Gunnison County Stockgrowers and more. It asks the Justice Department, which is acting on behalf of NPS in the Black Canyon case, to hold off on litigation proceedings for one year in the hope of negotiating an out-of-court settlement.

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Gunnison Country Times, 3/14/02

WATER QUALITY

Roaring Fork River water quality shows improvement

Water quality of the Roaring Fork River is better now than 14 years ago, largely due to mine reclamation that curbed pollutants. That's the conclusion of the "208 Water Quality Management Plan Revision for 2002," published in March by Robert Ray, water quality director for the Northwest Council of Governments. The 2002 report is based on a compilation of water quality studies done on the Roaring Fork and its tributaries since the first water quality plan was published in 1988. Field studies conducted for the 1988 plan turned up some areas of concern, but pollution from mine runoff appears to have abated since 1988, thanks to reclamation efforts. The primary pollution source in the river and its tributaries is dissolved solids. The report recommended a centralized wastewater treatment in the mid-valley to serve subdivisions and also that new subdivisions use centralized sewer treatment plants rather than individual septic systems, which can discharge bacteria into the groundwater. In addition, the report recommended that loss of riparian habitat should be controlled in land use planning, along with projects to stabilize stream banks, and reuse of water in the home and for landscaping.

Glenwood Springs Post Independent, 3/21/02

State may alter water-discharge permit on river

After reviewing objections from the Southern Ute Indian Tribe, state water-quality control officials say they will consider modifying a permit allowing J.M. Huber Corp. to discharge water from two coal-bed methane wells into the Florida River. The permit, the first ever issued in La Plata County, allows the company to discharge up to 576,000 gallons of coal-bed methane well water daily as long as the effluent falls at or below specific maximum concentrations. The company itself would do its sampling and reporting. The permit requires Huber to meet more stringent limits for dissolved minerals as of Jan. 1, 2006. The allowable milligram-per-liter values for chloride, for example, will drop from 1,500 to 130; boron from 2 to 0.4; selenium from 0.02 to 0.005; copper from 0.2 to 0.0059; and zinc from 2 to 0.091. The permit sets specific values the company will have to meet for dissolved minerals such as copper and zinc, which can affect trout, and boron and selenium, which can affect agricultural water and drinking water. "We'll be looking at all the effluent limits, and we'll look at the tribe's data to factor in to redo our analysis," said Dave Akers, permitting chief for the Water Quality Control Division of the Colorado Department of Public Health and Environment. The tribe has collected relevant water quality data from the Florida River since 1993, just downstream from the two discharge sites. Akers said the water-sampling data the division used was collected far upstream and downstream from the discharge site, so the tribe's information "could be more relevant."

The Durango Herald, 3/20/02

WATER SUPPLY/DEVELOPMENT

2 towns helping each other acquire water

Superior, the state's fastest-growing town last decade, is selling shares of Windy Gap water to Erie, so it can buy shares from other water sources. Cities such as Broomfield, Fort Collins and Greeley have invested in Windy Gap. Unlike Superior, these cities can wait years until Windy Gap is fully "developed" with a reservoir and better infrastructure, according to Joel Meggers, Superior's utilities and public works director. Superior plans to use the money from Erie to buy shares of Colorado-Big Thompson water, a source used by many Front Range communities. Erie Town officials plan to pay for the Superior purchase by selling 425 water taps for new homes.

The Boulder Daily Camera, 3/11/02

Impact study completed

The U.S. Army Corps of Engineers (COE) completed a study evaluating the effects Rueter-Hess Reservoir will have on the area. The EIS was required by COE because the reservoir and its diversion system, which pumps water from Cherry Creek to the reservoir, sit in wetland areas, said Parker Water and Sanitation District Engineer Jim Nikkel. The reservoir, which will store as much as 16,200 acre-feet of water and inundate 470 acres of land, will be used primarily in the summer, when average water use increases to three times that of winter use, due to lawn and landscape irrigation. It will affect 703 acres of vegetation and 6.7 acres of wetland. Once the construction begins, 704 acres of wildlife habitat would be permanently destroyed. The district, however, proposes to preserve 1,490 acres of habitat. Without the reservoir, the district would have to drill 284 wells to supply water to the increasing population. That would ultimately cost the district $225 million and would have an adverse effect on the water levels in the Denver Basin aquifer. However, it would not affect the flow of the Cherry Creek or as many acres of vegetation acreage, wildlife habitat or wetlands.

Douglas County News-Press, 3/6/02

Odds of more A-LP funding called good

Prospects for additional federal funding next year for Animas-La Plata look good, following a lobbying effort in Washington, D.C. Durango attorney Sam Maynes Sr., Southern Ute Tribal Chairman Leonard Burch, A-LP Water Conservancy District President Mike Griswold and

Southern Ute Tribal Council member Mike Olguin talked with members of Congress about boosting the Administration's request for $33 million in next year's federal budget by an additional $10 million. That increase would total the spending authority Congress approved.

Durango Herald, 2/13/02

Plan calls for sucking water from river to keep it in state

Lawyer and Colorado Water Conservation Board (CWCB) member Greg Hoskin will ask the CWCB to spend as much as $500,000 to study the idea of dipping a straw in the Colorado River at the Colorado-Utah border and pumping enough water for 2 million people a year back to the heart of the Rockies. The plan is officially known as the Colorado Aqueduct Return Project, or CARP. Hoskin prefers to call it "The Big Straw." The straw would take water at the Utah border and move it into one of three river basins sending water east, under the Continental Divide, but only after those on the Western Slope had their rightful crack at it. The Colorado River has become the backbone of a boom that has seen the Southwest's population grow from 8 million after World War II to more than 34 million people. Environmentalists, however, call the straw the latest check to be written on an already bankrupt river. The straw would suck water that now helps dilute a river some say is saltier than seawater when it empties into the gulf. Add projects such as the straw to uncontrollable changes in the climate, environmentalists say, and the river is at serious risk.

The Grand Junction Daily Sentinel, 3/17/02

Water action needed

Members of the committee formed to save the Fort Lyon Canal water say that the water may be lost if action isn't taken quickly. At a recent meeting of the newly named Arkansas Valley Water Preservation group, a concern was expressed that the group needs to act immediately to keep the water rights in the valley. Since December, a newly formed corporation called High Plains A&M has been buying options on land irrigated by the Fort Lyon Canal, which waters nearly 100,000 acres in Bent, Otero and Prowers counties. High Plains speculators are believed to be trying to buy 20 percent of the canal's water, which would amount to about 10 percent of the entire Arkansas River. John Rose, coordinator of the Otero County WaterWorks Committee, said the multi-county preservation group has more than 30 active members trying to preserve the water rights to protect the dynamics of the valley. A committee within the group is studying "entity structure," attempting to determine what type of political organization should be formed to best manage the needs in the Lower Arkansas Valley. Rose said permanent removal of water from the canal would adversely affect the valley's infrastructure.

The Pueblo Chieftain, 3/8/02

Local ranchers eye gas-well water

The prospect of another dry year prompted a rancher southeast of Durango to consider tapping the water produced by four coal-bed methane gas wells on his land. Currently about 38 gallons of water per minute, 24 hours a day, year-round, is reinjected underground by the gas well owner. The rancher's lawyer has filed a claim for the water on his behalf with the District Water Court in Durango. The rancher plans to dilute the well water with irrigation water and spray it on acreage beyond the reach of his irrigation sprinklers. The average well produces several thousand gallons of water a day, all of which is pumped back below ground. Some ranchers see that as wasting a valuable resource. But the key questions are, who owns the water, and is it safe to use on land? The legal question of ownership depends on how the water is defined, said several lawyers who specialize in water-rights issues. The Colorado Oil and Gas Conservation Commission, which regulates gas drilling, considers the water a waste product and requires it to be disposed of in reinjection wells. The agency does not decide the legal ownership of the water. Neither does the Colorado Department of Public Health and Environment, which sets quality standards for effluent discharged into surface waters. That leaves the issue of ownership to water courts. If he is allowed to use the well water, the rancher will build a reservoir for winter storage and the gas company will reinject the remaining water. But in addition to diluting the gas-well water, which be believes will greatly reduce the salt load.

The Durango Herald, 3/21/02

WILDERNESS

Three groups sue BLM over rivers

Three environmental groups have filed suit against the Bureau of Land Management for failing to study whether the San Miguel River is eligible for designation as a wild and scenic river. Taxpayers for the Animas River, based in Durango, joined the Center for Biological Diversity and Colorado Rivers Alliance in the suit, filed in federal District Court in Denver. The lawsuit alleges that six BLM field offices – Glenwood Springs, Grand Junction, Kremmling, Little Snake, San Juan and Uncompahgre – have violated the federal Wild and Scenic Rivers Act by not assessing the eligibility of rivers and streams in their boundaries for inclusion in the Wild and Scenic Rivers system. There are currently 160 river segments in the system since the act was passed in 1968. Of those, Colorado hosts only the Cache La Poudre River. Congress ultimately decides wild and scenic status, a process that can take years. In the interim, the BLM is required to develop and implement guidelines prohibiting dam construction and addressing recreational development, energy development and other practices.

***The Durango Herald*, 3/5/02**

MEETINGS

COLORADO WATER CONGRESS
FALL WORKSHOP SCHEDULE

The Colorado Water Congress prepares a series of six to ten workshops each fall for the purpose of increasing and updating water knowledge both for the actively involved water community and general public knowledge.

These workshops are all held in the Colorado Water Congress Conference Room, 1580 Logan Street, Suite 400, Denver, Colorado. A 2002 Water Law Seminar will be held on September 9-10, 2002, and our fall workshops will be announced as they are scheduled.

Colorado Water Congress - Summer Convention
Manor Lodge, Vail, Colorado — August 22 - 23, 2002

A 2002 Water Law Seminar will be held on September 9-10, 2002,
in the Colorado Water Congress Conference Room, 1580 Logan Street, Suite 400, Denver, Colorado

The 2003 45th Annual Convention will be January 23-24, 2003 in Northglenn, CO
The 2003 Summer Convention will be August 21-22, 2003 in Steamboat Springs, CO
The 2004 46th Annual Convention will be January 29-30, 2004 in Northglenn, CO

CONTACT: Dick MacRavey, Executive Director, at Phone 303/837-0812, FAX 303/837-1607, E-mail macravey@cowatercongress.org.
Web site: **www.cowatercongress.org**

COLORADO WATER WORKSHOP
Western State College, Gunnison, Colorado
July 31-August 2, 2002

The 27th Colorado Water Workshop at Western State College in Gunnison will acknowledge the Centennial of the 1902 Newlands Act this year with a focus on "Reclamation at the Century Mark: The Legacy and the Challenge." The Workshop will be held in Gunnison July 31-August 2. Please note that this a different date than was advertised in earlier issues of *Colorado Water*. A major scheduling conflict in the Gunnison area necessitated moving the date back one week.

The Workshop will focus primarily on the Bureau of Reclamation, created (as "the Reclamation Service") by the 1902 legislation, but it will also look at other large-scale public reclamation work at the municipal, state and regional levels. Much of the West was transformed by this work throughout the 20th century - most of the transformation intentional and beneficial, some if it unintended and problematic, and probably all of it under-appreciated by its beneficiaries today. Current Bureau of Reclamation Commissioner John Keys III, will make a banquet presentation at the Workshop on the Bureau's present and future mission, and other Bureau people will make presentations on more specific projects and issues. The Bureau's traveling Centennial Exhibit will also be present for the Workshop.

But in keeping with the mission of the Workshop, as articulated by founder Richard Bratton - that "every responsible position will be adequately represented" - the Workshop will also feature environmental perspectives on "Reclamation's Century," in an exploration of the challenge before the Bureau and other reclamation agencies at all levels in the coming century. Ed Marston, publisher of the High Country News will be one of the Workshop's featured speakers. Marston may have articulated the Workshop's intention best in a communication with the coordinator about the topic: "It's astounding to me, watching the divisive, divided society we live in, that an earlier society could have come together to build those dams. We're like barbarians left with something a more organized and cohesive society built and left for us. It's a great machine, but we can't agree what to do with it."

Brochures for the 27th Colorado Water Workshop will be mailed out in late May. The cost for participants will be $250. Meanwhile, according to Workshop Coordinator George Sibley, "We are still looking for ideas for specific sessions on the theme, and presenters for sessions." Anyone with ideas for, or questions about, the Workshop can contact Sibley at 970-943-2055, or email him at water@western.edu.

NATIONAL WATER QUALITY MONITORING COUNCIL
Working Together for Clean Water

Involved in water monitoring? Then, don't forget to REGISTER NOW for the third National Monitoring Conference: *Building a Framework for the Future*.

Register now and join us from May 20-23, 2002 on the banks of beautiful Lake Monona in Madison, Wisconsin, for the third national monitoring conference. Building a Framework for the Future is sponsored by the National Water Quality Monitoring Council, in conjunction with many of its member organizations. This important and unique conference is designed to foster interaction, information sharing, and innovation among colleagues involved in all aspects of water monitoring. Building a Framework for the Future is organized around several thematic tracks that form the foundation of monitoring programs: setting the stage for monitoring; field and lab methods for today and tomorrow; exploring opportunities in data management; making sense of the data; and data to information to action.

Through interactive workshops, presentations, posters, and facilitated discussions, we will explore collaborative efforts, highlight new and emerging technologies, examine changing expectations of monitoring, and share results and successes.

Come to Madison and share your ideas and expertise! This will be a working conference where we will all play a role in identifying the issues and next steps needed to build and promote a monitoring framework for the future! To view the conference agenda and to register for the conference, please visit the official conference website at www.nwqmc.org, or contact Dan Yates at 405/516-4972 or E-mail dan@gwpc.org.

call for posters

WHO'S RUNNING THIS ECOSYSTEM? 2002 SOUTH PLATTE FORUM, October 23-24, Raintree Plaza, Longmont, Colorado. You are invited to submit a one-page abstract to the organizing committee by August 1, 2002. Selected posters will be displayed throughout the forum with a staffed session from 3-7 p.m., Wednesday, October 23. To submit abstracts or request additional information, please contact: Jennifer Brown, South Platte Forum, 513 N. Harding Ave., Johnstown, CO 80534; Phone 970/213-1618, E-mail southplatteforum@msn.com.

CALENDAR

May 7-9	HARDROCK MINING 2002 -- Issues Shaping the Industry, Westminster, CO. Contact: Alina Martin, Phone 703/318-4678 ext. 1, FAX 703/736-0826, website http://www.epa.gov/ttbnrmrl/hardrock.htm
May 13-15	AWRA 2002 SPRING SPECIALTY CONFERENCE, COASTAL WATER RESOURCES, New Orleans, LA. Registration form, Preliminary Program online at **http://www.awra.org**.
May 20-23	NATIONAL WATER QUALITY MONITORING COUNCIL (NWQMC) CONFERENCE, BUILDING A FRAMEWORK FOR THE FUTURE, Madison, WI. Contact Dan Yates at Phone 405/516-4972 or E-mail dan@gwpc.org. The NWQMC web site is at **http://www.nwqmc.org**.
June 7-8	ARKANSAS RIVER BASIN WATER FORUM--PEAKS TO PRAIRIES: SHARING A WATERSHED, Colorado Mountain College, Leadville, CO. For information contact Charlie and Becky Goff at hollygoff@yahoo.com or by phone at 719/942-4688. The Forum web site is located at: **http://partners.uscolo.edu/arkriver/**
June 11-14	ALLOCATING AND MANAGING WATER FOR A SUSTAINABLE FUTURE: LESSONS FROM AROUND THE WORLD, Boulder, CO. Contact: Jeannie Patton, Event Coordinator at Phone (303) 492-1288 or FAX 303/ 492-1297 or See the Natural Resources Law Center web site at **www.colorado.edu/Law/NRLC/2002Conference.html**.
June 17-20	4TH INTERNATIONAL CONFERENCE ON CALIBRATION AND RELIABILITY IN GROUNDWATER MODELING: A FEW STEPS CLOSER TO REALITY, Prague, Czech Republic. For information call the International Ground-Water Modeling Center, Colorado School of Mines at 303/273-3103, FAX 303/384-2037, or visit the IGWMC web site at **http://www.mines.edu/research/igwmc/**.

CALENDAR

June 24-28	22ND ANNUAL MEETING AND CONFERENCE, U.S. Society on Dams, San Diego, CA. Contact: Larry Stephens, Phone 303/628-5430, FAX 303/628-5431, or E-mail stephens@ussdams.org
July 1-3	AWRA Annual Summer Conference, GROUND WATER/SURFACE WATER INTERACTIONS, Keystone, CO. For inquiries and questions contact: Jerry F. Kenny, Chair, Conference Technical Program Committee, Phone 303/764-1525, FAX 303/860-7139, E-mail jkenny@hdrinc.com; Patricia A. Reid, AWRA Program Coordinator, Phone 540/687-8390, FAX 540/687-8395, E-mail pat@awra.org; Michael J. Kowalski, AWRA Director of Operations, Phone 540/687-8390, FAX 540/687-8395, E-mail mike@awra.org. The AWRA web site can be found at **http://www.awra.org**.
July 10-13	ENERGY, CLIMATE, ENVIRONMENT AND WATER -- ISSUES AND OPPORTUNITIES FOR IRRIGATION AND DRAINAGE, San Luis Obispo, CA. Contact: Larry Stephens at Phone 303/628-5430, FAX 303/628-5431, E-mail stephens@uscid.org. Internet: **http://www.uscid.org/~uscid**.
July 23-26	INTEGRATED TRANSBOUNDARY WATER MANAGEMENT, Traverse City, MI. For further details, access the website at **http://www.uwin.siu.edu/ucowr/**. To receive future announcements, E-mail ewri@asce.org or ucowr2002@siu.edu, or call UCOWR headquarters at 618/536-7571.
July 31-Aug. 2	COLORADO WATER WORKSHOP, Gunnison, CO. Contact: George Sibley Coordinator, Colorado Water Workshop, Western Water Workshop, Gunnison, CO 81231, Phone 970/641-8766, FAX 970/641-6280, E-mail water@western.edu.
Aug. 27-29	WESTERN STATES WATER CONSERVATION ROUNDTABLE, Boise, ID. Sponsored by the "Bridging-the-Headgate" partnership. For information contact Allen Powers, USBR, Phone 208/334/1455 or Sue Lowry, Western States Water
Sept. 8-12	10TH NATIONAL NONPOINT SOURCE MONITORING WORKSHOP, Monitoring and Modeling from the Peaks to the Prairies, Breckinridge, CO. For details check the web site at **http://www.ctic.purdue.edu/NPSWorkshop.html** or contact Tammy Taylor at taylor@ctic.purdue.edu, Phone 765/494-9555 or FAX 765/494-5969.
Sept. 22-25	2002 GWPC ANNUAL FORUM, San Francisco, CA. Contact the Ground Water Protection Council, 13208 N. MacArthur Blvd., Oklahoma City, OK, 73142, Phone 405/516-4972 - Fax 405/516-4973. Forum information is available at the web site **http://www.gwpc.org**.
Oct. 23-24	WHO'S RUNNING THIS ECOSYSTEM? 13TH ANNUAL SOUTH PLATTE FORUM, Longmont, CO. Contact: Jennifer Brown, South Platte Forum, 513 N. Harding Ave., Johnstown, CO 80534, Phone 970/213-1618, E-mail southplatteforum@msn.com.
Oct. 23-26	USCID WATER MANAGEMENT CONFERENCE, Helping Irrigated Agriculture Adjust to TMDLs, Sacramento, CA. Contact: Larry Stephens at Phone 303/628-5430, FAX 303/628-5431, E-mail stephens@uscid.org. Internet: **http://www.uscid.org/~uscid**.
Nov. 3-7	AWRA 2002 ANNUAL CONFERENCE, Philadelphia, PA. Registration information available at the AWRA web site at **http://www.awra.org**.