

Aquaculture, a Global and State Growth Industry

Farming the Waters for Varied Payoffs

According to a recent WorldWatch Institute study aquacultural or fish farming output is growing at 11 percent a year, representing the fastest growing sector of the world food economy. In fact, fish farming is likely to overtake cattle ranching as a global food source by the end of this decade, says the report.

Is this global trend reflected in Arizona, a state with both fish farming and cattle ranching? Fish farming is in fact expanding in the state, although at a much more modest rate than is occurring at the global level. That it will outpace cattle ranching as a food source by the end of the decade is not even a possibility. Yet the World Watch Institutes' report of the benefits of aquaculture raises some interesting issues relevant to Arizona.

The report states aquaculture allows a more efficient use of natural resources than does cattle raising as measured by the effi-

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Growing houses on desert lands. As Arizona's population expands new housing developments are being built on former agricultural lands. Some of these lands have been extensively pumped for groundwater and may be areas of future subsidence. Subsidence will likely attract greater public interest as home and property owners experience its effects. (Photo: Mark Klett)

What Recourse is Available When Subsidence Damages Private Property?

The threat of land subsidence and earth fissures encourages wise groundwater use. With a heightened awareness of subsidence, however, some homeowners are now likely to find a cause to blame for any unexplained cracks in property and buildings. The next step would be to fix blame and seek restitution — or try to.

This situation raises various questions: What are the legal implications when a homeowner believes subsidence damaged his or her property? What recourse is available? Who would be liable? What compensation might be had?

In Arizona, there is no case law of private property owners suing to recover damages from subsidence, although some officials believe such cases are likely in the future. Subsidence is a fact of life in south-central Arizona, with over 3,000 square miles of the area affected by subsidence. This includes the expanding metropolitan areas of Phoenix and Tucson.

Earth fissures caused by ground failure in areas of uneven or differential compaction have damaged buildings, roads and highways, railroads, flood-control structures and sewer lines. Much of the damage has occurred in outlying areas, away from

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population centers. The state's growing population, however, is now settling in former agricultural areas, on lands that were extensively pumped for groundwater.

Tucson is taking action to cope with possible subsidence damage to private property. That Tucson should take the lead in this issue is appropriate since the city has long relied on groundwater, with the result that measurable subsidence has occurred in various areas of the city, including central Tucson. The affected areas are not recently settled developments but long-established residential neighborhoods.

In response, the City of Tucson is involved in a study to determine if cracks occurring in houses located in central neighborhoods are the result of subsidence. The areas contain a number of masonry houses, between 40 and 50 years old, with varied degrees of cracking, from hairline cracks to significant gaps in walls that can be seen through.

City officials attended neighborhood meetings to discuss the subsidence issue, at the same time inviting people who had a serious damages to file a claim. Forty-seven claims were submitted. This provided a suitable sample for the city to determine if cracking were the result of subsidence or some other cause.

"We are trying to determine what damages may have been caused by subsidence as opposed to what may not have been. That is really very difficult. The problem is that there are so many intervening factors that could be involved," says Terry Anderson of the Tucson Risk Management Department.

Anderson says that the city sent an insurance adjuster specializing in property damages to examine the sites. He photographed the cracks and gathered varied information; e.g. whether the cracks were interior or exterior, and constructed diagrams, identifying the rooms with cracks and indicating the direction of the break. This information was sent to a consultant who is in the process of determining the causes of the damage.

The study is still in process but preliminary results indicate the cracking was not likely due to subsidence. Surface settlement appears to be the a prime factor. The soil beneath houses built at that time often was not sufficiently compacted, at least by today's standards. Also building codes at that time did not require steel reinforcement of structures. Consequently the houses are prone to crack from various causes, including compaction problems, surface runoff and even landscape watering.

The Tucson study demonstrates the difficulty of attempting to establish a direct cause-and-effect relationship between subsidence and property damage. The cracks in a house could be caused by one, all or a combination of the above factors, including subsidence. A person seeking damages for subsidence would have to sort this out to pinpoint subsidence as the a direct cause for specific damages.

Also, if subsidence were demonstrably involved, identifying the responsible party or entity would not easy. Many pumpers may draw from an aquifer, including various utilities and a number of private pumpers. Further, pumping may have occurred over a long period of time. To associate subsidence damage with the activities of a particular pumper at a particular time would be very difficult.

The complexity of the task, not to mention the expense involved, would likely put off those inclined to file claims.

Homeowners are more likely to be successful when suing a developer for subsidence damages. Determining liability is less arduous when it can be demonstrated that a developer was negligent in choosing a construction site by not considering the possibility of subsidence. Developers usually hire consultants to check out the geological characteristics of a site before they build.

Even before seeking legal redress, however, most people who believe their property is damaged by subsidence would likely check their homeowners insurance policy for appropriate coverage. Disappointment awaits them. In a list of uncovered losses, the Allstate Insurance Company states, "Earth movement of any type, including, but not limited to earthquake, volcanic eruption, lava flow, landslide, subsidence, mudflow, pressure, sinkhole, erosion, or the sinking, rising, shifting, creeping, expanding, bulging, cracking, settling or contracting of the earth." These exclusions are typical of most homeowners insurance policies.

Curiously, however, although a rider will often be written for a policy to cover earthquake damage, subsidence does not qualify for the same consideration. The potential damage from earthquakes is considered more predictable. As an insurance industry representative explained, "This particular peril (subsidence) is one which can be affected by a number of human/governmental decisions for which actuaries can't accurately predict."

Some geologists would dispute the premise that subsidence is less predictable than earthquakes. According to an Arizona Department of Water Resources official, "You are probably better able to determine more accurately where subsidence might occur and its extent than an earthquake. First, however, the data must be available, and that might be the problem. Good historical information about changes in depth-to-water is needed for predictability, and that is not always available."

What recourse then is available for persons who believe their property is damaged by subsidence? Some officials acknowledge that such people are due some remedy, and the relief most often suggested is providing funds for house repairs.

Herb Schumann, consultant working on the Tucson projects, says, "Maybe it is more important to fix the damage than to point fingers at who did it. If it is subsidence, it is going to be damn difficult to blame it on anyone. The litigation would be complicated, and the cost would be prohibitive for paying for studies and the services of high-priced lawyers."

Terry Anderson suggests a possible source of funds for repairing subsidence damaged homes. The concept is similar to what is done to fund the program for remedying orphan waste sites caused by leaking underground storage tanks. The money for this program comes from a tax on the wholesale price of every gallon of fuel sold in Arizona. Anderson suggests that along the same lines water users could be taxed to provide funds for helping people repair homes damaged by subsidence.

Anderson says, "Politically it may not fly. Standards and guidelines would have to set up. Would assistance be income based? Etc. The concept is sound, but the details will kill it."



Water Vapors

Memories of Leonard Halpenny

by Barbara Tellman

Leonard Halpenny's death in November left a void in the Arizona water community, but his work over 60 years in Arizona has left a lasting mark. Leonard was a true pioneer in many ways, although he arrived here in 1939 after the great age of pioneering was over. He had an endless curiosity as well as an ability to innovate when the technique he needed had not yet been invented. He also viewed his results as work-in-progress and expected that someone in the future might well revise his work as knowledge and techniques developed.

There are few Arizona watersheds that Leonard did not at some time study over those sixty years. And when he was not studying Arizona, he worked in Latin America and Africa. One South American rancher benefitted so much from Leonard's work that he invited him back for working/social visits for many years.

Leonard kept careful track of his projects in a notebook which listed them by year, but he also retained most of that information in his excellent memory. Here is just the tip of the iceberg from his life work: In 1940, his first Arizona publication as a USGS employee was a study of groundwater recharge at Queen Creek. In 1943, he published a study of the groundwater resources of the Santa Cruz basin. After World War II, he and his colleagues began a major study of the water resources of the Navajo Nation which resulted in numerous publications over the years, revealing an enormous amount of information about a hitherto hydrologically and geologically unknown area. In the 1950s, he published studies done in the previous decade of saltcedar invasion along the Gila River and worked on some of the major studies of saltcedar from the hydrological viewpoint. During the same time, he studied springs along the Mogollon Rim. By 1956, he had formed his own company and his area of interest had spread to Portuguese West Af-

rica where he studied groundwater resources along the coast. A complete list of the areas where he conducted studies is far too long for this article, but there are very few basins in Arizona that he did not study.

Leonard was also committed to making his work useful. In the 1940s and 1950s, people began to be concerned about the depletion of the aquifers. When the Arizona Legislature began looking at revising the groundwater law, Leonard's studies of water supplies along the Gila and Salt rivers were crucial to passage of the first groundwater law in 1948. He continued to provide useful information to the Legislature over the years in ways they could understand and often testified before them to urge sensible use of water based on scientific information. Unfortunately, they did not always listen to him. He played a major role in development of the Groundwater Management Act in 1980.

Leonard also spent a great deal of time in court, not as an alleged criminal, but as an expert witness on water cases, most notably the Arizona v. California litigation



Leonard was active into his 80s. In this 1994 photo he uses a homemade sounder to measure water levels in a well. (Photo: Phil Halpenny)

over the Central Arizona Project. His breadth of information was astounding and often critical in decision-making. He served as Special Master in the landmark federal water rights case, Cappaert v. United States.

He enjoyed his reputation as a curmudgeon and delighted in challenging accepted beliefs. He reveled in talking about enemies he had made over matters of principle. He was tireless and drove long distances at a rapid speed in his excitement about his work. He had a great sense of humor which was reflected in the many amusing stories told about him at his memorial.

People interested in honoring Leonard Halpenny are invited to contribute to a scholarship fund set up in his memory by the Arizona Hydrological Society, c/o Montgomery and Associates, 1550 E. Prince Rd., Tucson AZ 85719.



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Arizona Water Resource Staff

Editor: Joe Gelt
 Editorial Assistant: Joel Spezeski
 Reporters: Val Little
 Barbara Tellman

www.ag.arizona.edu/azwater

WRRC Director: Dr. Peter Wierenga

Arizona Water Resource

Water Resources Research Center
 College of Agriculture and Life Sciences
 The University of Arizona
 350 North Campbell Avenue
 Tucson, Arizona 85719

520-792-9592; FAX 520-792-8518
 email: wrrc@ag.arizona.edu



News Briefs

Study Reconsiders Role of Invasive Saltcedar

University of New Mexico researchers have found that cottonwood tree seedlings can out compete invasive saltcedar after natural flood cycles. The findings, which gladden many conservationists, is contrary to the prevailing belief that natural flood cycles actually spur the growth of the invasive species to the disadvantage of native species. Researcher Anna Sher says, "Our results suggest that even in the presence of an invader that responds positively to disturbance, reestablishment of historical flooding regimes ... can restore this ecosystem by promoting its dominant plant species."

Since early last century, the natural flood cycles of many Southwest rivers have been disrupted by damming and channeling. This interfered with the growth of native cottonwoods that rely on flooding to propagate. Meanwhile the non-native saltcedar, tolerant of salinity, drought, and fire, thrived, with the result that saltcedars replaced cottonwood as the dominant tree along many western rivers.

Sher and her colleagues collected seeds from both cottonwood and saltcedar and planted them in 18-inch deep plastic pipes, varying the seedling densities from low to high. The researchers then simulated flood conditions by submerging the bottom six inches of the pipes in water. The researchers concluded from the resulting seedling growth that restoring historical flooding cycles could help reestablish cottonwoods even in habitats with saltcedar seedlings. They cautioned, however, that cottonwood seedlings might not survive in riparian areas with adult saltcedars. Such trees may have to be removed first. Sher and her co-authors published their findings in the December issue of "Conservation Biology."

Law Suit Says Verde River Due More Protection

A law suit was recently filed to ensure that the Verde River gets the federal protection that is its due from its "wild and scenic"

status. A 40.5-mile segment of the river was designated 16 years ago as a wild and scenic river. The lawsuit, filed on behalf of a number of local and national river conservation groups, alleges that the U.S. Forest Service violated the National Wild and Scenic River Act by failing to prepare a comprehensive management plan for the river.

The Verde Wild and Scenic River is the only Arizona river designated as part of the National Wild and Scenic Rivers system. Congress provided the designation in 1984 because of the river's "outstanding remarkable values."

The suit objects to the way the Verde Wild and Scenic River is presently being managed, by three separate National Forests and three separate management plans. "This piecemeal approach towards managing one of the nation's most treasured rivers is not only a threat to the Verde's unique natural resources, it is also illegal," says Mathew Bishop of the Western Environmental Law Center. Threats to the river include poorly planned or regulated livestock grazing, recreational pressures, irrigation projects and decreased flows.

The law suit seeks a declaratory judgment that the Forest Service is in violation of the Wild and Scenic Rivers Act and also asks for a mandatory injunction to require the agency to prepare and adopt a coordinated management plan within one year after the final judgement.

"The lawsuit will be closely watched by river conservation groups nationwide, and could set a nationwide precedent if the court orders stepped-up protection of the Verde River," says Jack Hannon of American Rivers.



Heavy October rains caused a vigorous flow of the San Pedro River in southeastern Arizona. Rain falling in Sonora over the weekend of October 23-24 sent a 15-foot wall of water down the river, flooding the San Pedro Riparian National Conservation Area. Usually about 6 to 8 feet wide, the river spread half a mile wide. Near Palominas, the water was traveling at 17,500 cubic feet per second, with a higher flow through the area than Colorado River flow through the Grand Canyon. This was the highest flow recorded since 1940, according to the National Weather Service. President Clinton signed a declaration approving flood damage money for the area. (Photo: Anne Kramer Huth)

Agencies Grant Awards for Water Projects

Two Arizona programs that fund water projects recently announced successful grant recipients. The Arizona Water Protection Fund supports the development and implementation of measures to maintain, enhance and restore rivers, streams and associated riparian habitat.

The projects to receive AWPFF funding are: Arizona Historical Society, \$229,152; Mt. Graham International Science and Culture Foundation, Inc., \$152,851; Kevin McCormack, \$66,330; Apache-Sitgreaves National Forest (2) \$258,228, \$35,515; Colorado River Indian Tribes, \$234,825; Hubbell Trading Post National Historic Site (2) \$69,349, \$61,951; Hopi Tribe \$267,511; David Movius, \$34,416; Tucson Audubon Society, \$127,409; Santa Fe Ranch, \$49,008; Redington NRC, \$249,871; Northern Arizona University, \$249,723; Double Check Ranch/TNC, \$203,701; Tres Alamos Ranch, \$77,658; and Town of Eager/Round Valley Water Users

Association, \$151,829.

Administered by Arizona State Parks, the State Lake Improvement Fund assists state and local units of government fund projects on water where boats are permitted. The fund provided support for ten

grants including \$250,000 to La Paz County for an engineering study of the technical and economic viability of a lake in the vicinity of Bouse. The largest grant, \$1 million, went to Prescott for enhancing and expanding Willow and Watson lakes.

The other recipients are Mohave County, (2) \$904,310, \$244,414; Bullhead City, \$310,000; La Paz County, (3) \$69,900, \$372,500, \$250,000; Gila County, 299,650; Camp Verde, \$113,995; Arizona Game and Fish, \$543,407; Prescott, \$1 million.

Dual Meters, New Tool to Study Water Use

A dual metering system measuring indoor and outdoor water use that is being installed at 32 of the 58 homes under construction at Sagewood, a development under construction in northwest Tucson, is the first step of a long-range plan to study water consumption patterns. The water use information recorded by the dual measuring devices will be used to devise water conservation strategies.

The pilot project officially got underway when The Genessee Co, builder of Sagewood, joined with the Water Conservation Alliance of Southern Arizona (Water CASA) and the Flowing Wells Irrigation District and agreed to allow installation of the dual meters at its new subdivision. The U.S. Bureau of Reclamation provided a \$30,000, three-year grant to pay for the project. Water CASA, a Water Resources Research Center program at the University of Arizona, is a cooperative of small water utilities and includes the Flowing Wells Irrigation District.

A hard hat luncheon on Dec. 1 marked the sinking of the first dual-metering system in the ground at Sagewood. Val Little, director of Water CASA says, "As far as we know, this is the first project of its kind in the nation."

Data will be gathered for over 20 years for a longitudinal study of changes in water use that occur seasonally and as landscapes mature and families grow or change. This type of water use data has not been readily available and will enable officials to test the effectiveness of a variety of water conservation strategies.

Project plans call for dual systems to be eventually installed at two other subdivisions. The goal is to have three dual-metered developments, with starter homes, mid-range and high-end homes. With three separately priced subdivisions the research possibilities of the project broaden to include an examination of socio-economic variables affecting water use.

Researchers will be able to select households from the different dual-metered housing developments to create a population mix or sample to test particular water conservation strategies. Through this mixing and matching among communities a population sampling can include various socio-economic factors along with other variables. A control group also can be identified.

Before this phase of the project begins a mid-range and a high-end subdivision also must be dual-metered. Little says they are looking for cooperative subdivisions in areas served by two other Water CASA utilities, Metro-Ora Valley and the Town of Marana. The Genessee's Sagewood community represents a starter community, with homes beginning at \$94,000.

For additional information about the dual-metering project contact Val Little at 520-792-9591, ext. 12; email: vlittle@ag.arizona.edu



This new subdivision is the site of an innovative water conservation effort, as dual meters to measure indoor and outdoor water use are installed. (Photo: Kerry Schwartz)

AZ WaterCommunity NEWS

The *Life of the Santa Cruz River*, a traveling exhibit with facts, information, stories and pictures about the Santa Cruz River, is now on display at the Mesa Museum of the Southwest. The 1,500-square-foot exhibit was the result of a cooperative effort, involving museum staff along with Arizona writers, including Water Resources Research Center's Barbara Tellman, archaeologists, scientists and historians and is sponsored by more than two dozen organizations.

A dedication ceremony for the **Lower Santa Cruz Recharge Project** was held November 2. Located in the town of Marana, the LSCRP is a joint project involving the Central Arizona Project, the Town of Marana, the Pima County Flood Control District and BKM Farms. It has permitted capacity to store 30,000 acre-feet of Colorado River water per year.

Hanna Cortner, former director of the WRRC, is resigning her position at the University of Arizona's School of Renewable Natural Resources and has accepted a faculty position with the Ecological Restoration Institute at Northern Arizona University.

Mohammad al-Asad, director of the Center for the Study of the Built Environment, a research institute in Amman, Jordan, visited the University of Arizona to work out an international memorandum of agreement with the UA Center for Middle Eastern Studies. Dr. al-Asad also met with Val Little of WRRC's Water CASA to acquire information about graywater use.



Guest View

Water Researchers Take Their Results to the Media

Gary Woodard contributed this Guest View. He is Assistant Director for Knowledge Transfer at the University of Arizona's Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA). His comments are in reference to the research described in "Special Projects" page 9 of this newsletter.

Water stories often receive considerable media attention in Arizona, and co-author Jim Henderson and I knew our study of aging ultra-low flush toilets might get more than its share. This was satisfying in a way, because university research does not usually attract much media attention. Yet our sense of satisfaction was tempered by concern that the results of our work be reported fully and accurately. We knew our study waded into controversial waters.

The controversy has to do with the mandated use of low-flush toilets – a controversy resounding even in the halls of Congress. Representative Joe Knollenberg, R-Michigan, annually sponsors a bill to end federal requirements that all new toilets flush with 1.6 gallons, instead of the 3.5 gallons of the older models. Last session's bill did not pass, but it is likely to be reintroduced this year. Representative Ed Pastor, D-Arizona, was among 14 Democrats who co-sponsored the bill. Environmentalists and others concerned about conserving water oppose the bill.

Our study found both good and bad in the operations of seven-year-old low-flush toilets, with the result that both sides of the controversy could claim our work supports their side. A careful reading of the report would show, however, that although we faulted the operation of some makes and models of toilets, we did not conclude that these deficiencies justified discontinuing the use of ULF toilets in general. Instead we recommended the adoption of certain design standards. It was essential that this point get across in the media coverage.

We were not disappointed about the extent of media coverage – to date, stories have appeared on five TV stations, in at least five newspapers, and on a handful of radio stations. Headlines include the *Tucson Citizen's* "Water-saving toilets' benefits go down drain" and KVOA's alliteration regarding "problem porcelain." Another station had a working story title befitting a horror show – "When good toilets go bad!"

We had discussed various options for releasing the study report to the media, including issuing a press release, holding a press conference, and/or calling one or two trusted reporters. In the end, we opted for a press release coupled with phone calls to a handful of reporters whom we knew were experienced in covering water stories. We hoped this might result in both quick, wide dissemination and coverage that was fair and accurate.

A major concern was the spin that the media would put on the story – would they see the toilet tank as half empty or half full? With an alarming 43 percent of the tested toilets having one or more water-wasting problems, a negative tone could be justified.

Still, 57 percent were still working as advertised after eight years, which doesn't sound so bad.

Headlines ran the gamut from the University of Arizona's *Arizona Daily Wildcat* proclaiming that "Low-flow toilets save Tucson money, UA researchers say" to the decidedly more pessimistic *Arizona Daily Star* headline, "Study: Low-flow toilets waste water." While the headlines, which are written by editors, were all over the map, the stories themselves were more consistent. And TV stations, which usually can devote only a minute or two to stories, and sometimes use a single quote pulled out of context from a lengthy interview, gave the story considerable air time to present a balanced story. Frankly, we benefitted from some slow news days.

Still, releasing one's research results to the media can be unnerving. Research is all about creating a controlled environment, systematically changing some aspect of it, and recording the results. Going to the media, or having them come to you, means a near-total loss of control. One can preserve at least the illusion of control by following a few simple rules.

First, before releasing your report, try to imagine all the ways in which it could be mis-construed. If controversy is possible, pay attention to not only what you say, but how you say it. Our report makes pointed comparisons about the quality and reliability of specific makes and models of toilets, so we ran it by a university attorney. His job isn't to discourage or prevent researchers from saying anything, but rather to give useful advice on how to say something in a clear and defensible manner.

Second, know what the media want and try to help them. Some stories are better suited for print media, others for TV or radio. TV demands strong visual images; be prepared to pose with a flushing toilet if asked. TV also requires stories that can be reduced to a couple minutes. Reduce the gist of your work to a couple sound bites if possible. Members of the print media appreciate easy-to-interpret graphics for their readers.

Third, don't be overly pretentious and believe that you know what the story is, or even what *kind* of a story it is. That is for the reporters to decide. Our ULF toilet study has been treated as a water resource story, a consumer protection issue, and as news of the bizarre.

Some reporters want more details or a unique "angle" to the story. We were able to refer them to various spokespersons, including an articulate hardware store employee who enjoyed being in front of a camera, a knowledgeable water utility conservation head, and owners of toilets that exhibited certain problems.

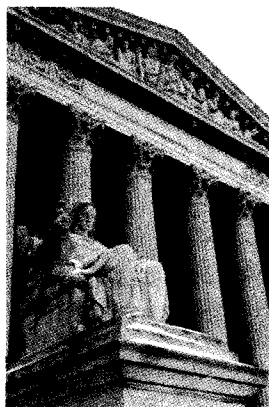
Finally, try to get to know the reporters covering your area, and work with those whom you are confident are concerned about accuracy and completeness. When a well-written story appears, give the reporter some positive feedback. That way, if you later have a concern or complaint, they are more likely to take it to heart.



Legislation and Law

U.S. Supreme Court Ruling on Wetlands May Be "Showdown"

In a case being closely watched by environmental and civil liberty groups, the U.S. Supreme Court heard arguments in November testing the extent of the U.S. Corps of Engineers authority under the Clean Water Act. The issue at hand appears to be another incident in the ongoing dispute between local officials and the federal government over development rights. Yet underlying the case is a broad challenge to the way the federal government protects not only the environment but, more broadly, civil rights.



The details of the case involve a group of local governments wanting to build a landfill on about 17 acres of wetlands near Chicago. The Corps blocked the project because ducks, geese and other protected waterfowl sometime use the land as a stopover when migrating.

The Corps based its denial on the federal Clean Water Act. The CWA authorizes the Corps and the Environmental Protection Agency to regulate pollution that is discharged into "the waters of the United States."

The Corps also brought up a Constitutional argument when it referred to "interstate commerce" in denying permission for the dump. According to the Corps, bird watchers and hunters travel across state lines to view the migratory birds at the wetlands and this constitutes a form of "interstate commerce."

Much of the federal government's regulatory power is based on the section of the Constitution giving Congress power over "interstate commerce." An increasingly expansive definition of commerce gave a green light to the rapid growth of the government's regulatory apparatus in the latter half of the 20th century. Implications of the principle are used as the legal basis for various federal civil rights protections including those relating to housing, employment and education.

The Solid Waste Agency, the organization that planned to build the landfill on behalf of the 23 Illinois municipalities, claims the Corps had no right to use the CWA to regulate the types of wetlands located on the proposed dump site. It said the intent of the CWA is to prevent the polluted discharge into "navigable waters," not the type of shallow, isolated ponds found on the proposed landfill site. Further, the agency rejects the Corp's argument that the migratory birds are related to interstate commerce.

The case is testing whether the Constitution's commerce clause permits federal intervention in wetlands in economic terms, and, therefore, whether the Corps' authority is in fact valid under the CWA.

After a trial court and the Chicago based 7th Circuit Court of Appeals rejected the SWA's claim the agency took its case to the Supreme Court.

What concerns many people is the Supreme Court's series of rulings over the past five years that chips away at federal power over states. The Court has taken this course by applying the general principle that the commerce clause is not applicable to non-economic activity within a state's borders.

Elliot Minberg of the liberal advocacy group People for the American Way says the nine-member court is closely divided on a series of rulings limiting federal powers and could use the case as a showdown over the importance of local versus federal control.

The case is *Solid Waste Agency of Northern Cook County v. Army Corps of Engineers*, 99-1178. The court is not expected to issue its ruling on the case until June.

Federal Agency Declares Endangered Species Moratorium

To the consternation of many environmentalists the U.S. Fish and Wildlife Service has declared a moratorium on adding new species to the Endangered Species List until September 2001. The agency reports that current lawsuits filed by environmental groups are draining its financial and human resources.

"We have reached the point where the staff time and funding needed to list species have been consumed by the requirement to do court ordered critical habitat designations stemming from a flood of lawsuits," said FWS director Jamie Rappaport Clark. "Unfortunately many species that should be listed in the coming year won't be listed."

The moratorium will allow FWS to concentrate on court ordered critical habitat designations and only make emergency listings of species in imminent danger of extinction. Also, action will be taken on listings either in the final stages of approval or funded by leftover appropriations from fiscal year 2000. The 25 species currently being considered will have to wait until after September 30 for possible listing.

FWS once considered designating critical habitat as a low priority while devoting its limited resources to listing threatened and endangered species. As a result, the service missed the deadline for designating critical habitat for about 90 percent of the 1,234 species listed under Endangered Species Act. FWS now faces court-ordered designations for nearly 300 species.

The decision has irked many conservationists. Those who believe that politics not science determine listings have found confirmation for their views. Other say the agency's financial difficulties stem from its low congressional budget requests. The \$7.2 million requested for fiscal year 2001 is less than the 7.5 million requested last year. Both figures are about \$3 million less than the 1992 request under the Bush administration.



Publications

The Drinking Water Dictionary

The American Water Works Association

This dictionary for water professionals provides definitions for over 15,000 words related to drinking water including acronyms, abbreviations, and hydraulic formulas. The Drinking Water Dictionary also includes a searchable CD-ROM. The dictionary is available for \$194 plus shipping and handling from the American Water Works Association, 6666 W. Quincy Ave., Denver, CO 80235; phone: 1-800-926-7337.

Whereas the typical dictionary would define "coupon" as some kind of certificate or document the AWWA Drinking Water Dictionary (see above) defines coupon as "a piece of metal or other material used to evaluate the rate of corrosion or deterioration due to exposure to the water of interest."

San Pedro News and Comment

Udall Center for Studies in Public Policy

The Udall Center for Studies in Public Policy distributes this weekly compilation of news articles pertaining to the following topics in the Upper San Pedro River Basin: water, land use and growth, ecology, endangered species, U.S.-Mexico border issues and weather/climate change. To receive this compilation, send an email request to Rachel Yaseen at rachely@u.arizona.edu. An online archive may be viewed at <http://udallcenter.arizona.edu>

Preparing for Climate Change: The Potential Consequences of Climate Variability and Change for the Southwest

Institute for the Study of Planet Earth

This report adds background to today's headlines of forest fires, quality of urban living, infectious diseases, and the sustainability of fresh water resources. It is written for everyone with an interest in nature's influence on society and the environment. It is one of 16 studies that contribute to a nationwide assessment of the potential implications of climate change. The report is available on the web at <http://www.ispe.arizona.edu/research/swassess> or to request a printed copy, contact: William A. Sprigg, Institute for the Study of Planet Earth, 715 N. Park Ave (2nd floor), The University of Arizona, Tucson, AZ 85721; phone: 520-622-9014; email: wsprigg@u.arizona.edu

University of Denver Water Law Review

University of Denver

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for students. To subscribe contact Water Law Review, University of Denver College of Law, 7039 East 18th Avenue, Denver, CO 80220; phone: 303-871-6223; or visit <http://www.law.du.edu/waterlaw>

A Field Guide for the Assessment of Erosion, Sediment Transport, and Deposition in Incised Channels of the Southwestern United States

John T.C. Parker, United States Geological Survey

The USGS has published a field guide for recognizing and interpreting the workings of erosion and deposition upon the landscape of southwestern deserts. The guide was written to enable nonspecialists to look at erosional and depositional features in the desert and get an idea of what forces have shaped the land in recent geologic history and how these forces are likely to affect the land in the future. It can be purchased from the U.S. Geological Survey, Branch of Information Services, Box 25286, MS517, DFC, Denver CO 80225-0286; call 303-202-4210 for ordering information.

Water Systems Handbook

Water Systems Council

This handbook is a comprehensive technical manual on the proper siting, construction, and operation of wells. It is written for novices in the industry, as well as experienced drillers, pump contractors, engineers, and end-users. The handbook includes information about well sources, disinfection, and design. The Handbook costs \$20, which includes shipping and handling. It is available from the Water Systems Council, National Programs Office, 13 Bentley Drive, Sterling, VA 20165; Phone: 703-430-6045; or visit <http://www.watersystemscouncil.org>

Two USGS Online Water Resources

USGS Water Quality Data Warehouse (<http://water.usgs.gov/nawqa/data>) is an online resource of water quality information. Intended to help water resource managers, scientists, and the public find data about the water quality at thousands of wells and stream sites, this data warehouse contains over 6.5 million records. The data were collected by the USGS National Water-Quality Assessment Program beginning in 1991 in 36 basins around the country.

USGS Drinking Water Programs are featured on a new website (<http://water.usgs.gov/owq/dwi/>). The site provides descriptions and links to 216 USGS projects and reports from all states that involve some aspect of drinking water quality. Projects are listed conveniently by state, and are cross-referenced by topic. A separate page lists drinking water projects and reports with a nationwide scope. Links also are provided to numerous external drinking-water websites.



Special Projects

Long-Term Performance of Low-Flush Toilets Studied

A recently released report examines the performance of aging water-conserving toilets purchased during Tucson Water's 1990-95 rebate program. The study, funded by the City of Phoenix and the U.S. Bureau of Reclamation, investigated whether some models of low-flush toilets are more prone to leaking, using more water, or needing multiple flushes, particularly as they age.

The focus of the University of Arizona's Water Resources Research Center study was 170 households that participated in Tucson Water's toilet rebate program during 1991-92. Researchers Jim Henderson and Gary Woodard studied the performance of rebate toilets seven to eight years after installation. The sample included 20 different models of low-flush toilets.

Data loggers attached to each home's water meter continuously recorded water use for a four-day period. The data traces then were analyzed using specialized software, which identified different water uses and measured volume and number of flushes for each toilet. Problems detected by the data included high-flush volume (greater than 2.2 gallons per flush), double flushing (considered a problem if occurring once a day or more) and flapper leaks.

Data logging revealed that more than half (57%) of the targeted homes had no detectable problem with the functioning of their toilets. The data, however, also indicated the following:

- The average flush volume of all rebate toilets was 1.98 gallons per flush (gpf), about 24 percent higher than their designed 1.6 gallons per flush. 26.5 percent of households had at least one rebate toilet with a flush volume averaging greater than 2.2 gallons gpf.
- Double flushing occurred in 14.2 percent of homes with rebated toilets or 10.9 percent of rebated toilets.
- At least 12.1 percent of households had recurring flapper leaks in their rebate toilets.
- Overall, 43 percent of the toilets exhibited one or more of these water-wasting problems.

The toilet's inner workings or, in other words, its flush valve type, determine effectiveness of operation or water use. The study identified five flush valve types used in low-flow toilet models: pressurized, early-close flapper, standard flapper, toilet dam/flapper and tube and bell.

The study examined each flush valve type to determine its performance with regards to high flush volume, double flushing and flush valve flapper leaks. Also reported was the performance of various brand name toilets using the different flush mechanisms. Further, the performance of low-consumption flow toilets and non-low-consumption toilets was compared.

When the 1.6 gallon flush was established as the national standard for low-consumption toilets, most manufacturers retained the 3.5 gallon tank, installing either an early-close flush valve or a toilet dam to reduce the flush to 1.6 gallons. Other manufacturers modified the standard toilet design by using a smaller trapway and a steeper bowl. With its smaller tank capacity these toilets could use the standard flapper as a flush valve to achieve the 1.6-gallon flush.

Still other manufacturers relied on toilet dams to reduce flush volume. A toilet dam works with a standard floating flapper and a 3.5-gallon tank by retaining water in the tank during a flush. The tube and bell flush mechanism has a rubber bell that slides up a tube to flush and slides back down to close the valve. Other low-consumption toilets use pressurized flush technology to achieve the 1.6 gallon flush. These are generally more expensive and require specialized parts.

One identified design problem is homeowners installing improper replacement parts and inadvertently reducing toilet water use efficiency. While a toilet is projected to last about 20 years, the typical flapper is expected to need replacing in about five years, or three times during the life of a toilet. If an early close flapper is replaced with a standard flapper, the toilet reverts to its 3.5 flush.

A householder might easily make this mistake since most hardware and home-improvement stores stock only traditional flappers. Early-close flappers often must be obtained from the manufacturer. The researchers found that 85 percent of the homeowners needing to replace flappers purchased a replacement at a hardware store.

Plastic toilet dams can be easily removed, with the result that the toilet will revert back to a 3.5 gallon flush, although it is unlikely such a removal would be done inadvertently. Intentional removal of toilet dams could be prevented if they were cast as part of the tank. Toilets with a smaller tank capacity using a standard flapper as a flush valve are less easily modified to increase flush volume.

Halogenated toilet bowl cleaners in the tank can cause the flapper to deteriorate, resulting in leakage. The study reports that 24 percent of those who knew they had flappers as toilet flush valves used in-tank bowl cleaners. This may account for the deterioration of rubber or plastic toilet parts. Also, high concentrations of chloramine, a residual disinfectant used in some water systems, can deteriorate rubber toilet parts such as flappers.

The researchers emphasize that their results do not suggest that efforts to mandate low-flush toilet use are misguided. Instead they say design flaws or improper replacement of parts usually account for the excessive water use. To help remedy the situation they recommend that the water industry adopt standards for toilet designs that are not alterable and that rebates or direct install programs not include toilets with alterable designs or with specialized parts that are difficult to find or replace.

The report, "Functioning of Aging Low-Consumption Toilets in Tucson," was written by Gary Woodard (email: gwoodard@hwr.arizona.edu) assistant director of the UA's Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA), and Denver consultant Jim Henderson (email: jlhenders@earthlink.net). Copies can be obtained by contacting WRRC or as PDF files from its website: www.ag.arizona.edu/azwater/

See "Guest View" on page 6 for report of researchers' efforts to ensure accurate media coverage of their research.



Announcements

Call for Abstracts

The Battelle Memorial Institute, a not-for-profit research organization, is sponsoring a conference entitled "Wetlands and Remediation: The Second International Conference," to be held September 5-6, 2001, and a call for abstracts has been issued. Potential conference topics include: natural attenuation in wetlands; biological and ecological considerations; risk-based wetlands remediation; regulatory trends; economic factors in wetlands remediation and restoration; wetlands for the remediation and treatment of wastewater; and groundwater/surface water interfaces. The deadline for abstracts is March 5, 2001. For more information, contact Carol Young, phone: 614-424-7604; email: youngc@battelle.org or visit <http://www.battelle.org/wetlandscon/>

Conference Anticipates Drier SW Climate

A multidisciplinary gathering, entitled "Predicting hydrologic, geologic, and biologic responses to a drier and warmer climate in the desert Southwest" will be held April 23-25 in the second floor conference room of the Environmental and Natural Resources Building at the University of Arizona. The U.S. Geological Survey conference is in response to long-term, climate forecasts indicating that the present relatively wet climate regime of the Southwest may change to drier and warmer conditions for the next 25-30 years. Results of the workshop include: an integrated data set on past

landscape responses to climate variation; predictions of future landscape response to climate change; identification of flood and mass wasting hazards; potential preservation of natural resources and habitats; and continued collaboration between the various divisions of the bureau. Experts from various fields will be attending. For additional information contact: Robert H. Webb, USGS; phone: 520-670-6671, ext. 238; email: rhwebb@usgs.gov

\$100,000 Water Quality Research Award

The Water Environment Research Foundation will present a \$100,000 annual award honoring the late Paul L. Busch, Ph.D., who served as chairman and chairman emeritus of WERF's Board of Directors. Through this award, WERF will recognize outstanding and innovative individuals or teams who contribute significantly to water quality research. The Endowment Awards Committee will evaluate applications for this annual prize and will reward those proposals that best combine advances in water quality research with practical applications. Nominations will be judged on innovation, creativity, feasibility, and potential benefit to the water environment. Applications must be postmarked by June 1. For more information, contact: Jane Knecht, WERF; phone: 703-684-2470, ext. 7149; email: jknecht@werf.org; or visit: <http://www.werf.org>

U.S.-Mexico Border Conference

The third annual Encuentro on the Border Environment will be conducted in Tijuana, Baja California, April 26-28. Considered one of the most important regional gatherings on environmental and public health issues, the Encuentro brings together hundreds of non-governmental and community based organizations from both sides of the border to discuss key issues, share experiences and compare strategies. For more information contact Evelyn Alvarez, Latin American Area Center, University of Arizona, PO Box 210028, 103 Douglas Bldg., Tucson, AZ 85721; phone: 520-626-8197; email: bordenv@u.arizona.edu

Water Management Conference

The American Water Works Association and the Water Environment Federation are jointly sponsoring a conference entitled "Defining Excellence," February 4-7 in Portland, Oregon. The conference is for water and wastewater professionals, and topics to be addressed include the following: competitiveness, technology, contract operations and privatization, best business practices and innovations, strategic planning, management-staff relations, customer service, operations and maintenance and finance. The conference will provide an overview of managerial trends and issues and seek to provide answers for management challenges. For more information call 1-800-926-7337. To register online visit the AWWA's website at <http://www.awwa.org/01jmc>

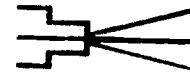
Student Scholarships Available

The Association of Dam State Dam Safety officials is offering a total of \$5,000 for the 2001-2002 school year through its Dam Safety Scholarship Program to help develop future leaders in the area of dam safety engineering. The scholarship is open to juniors and seniors in an accredited civil engineering program or in a related field. Applicants must demonstrate an interest in pursuing a career in hydraulics, hydrology or another discipline related to the design, construction and operations of dams. Applications are due on February 16. For an application form, call ASDSO at 859-257-5140.

The Wilderness Society invites applications from graduate students in natural resources management, law, or policy programs, for the Gloria Barron Wilderness Society Scholarship. The \$10,000 award supports research and the preparation of a paper on an aspect of wilderness in North America. Deadline is March 1. Contact: Richard Sawicki, Ecology and Economics Research Dept., Wilderness Society, 1615 M St. NW, Washington, DC 20036. Telephone: 202-429-3944. E-mail: richard_sawicki@rws.org Web: http://www.wilderness.org/newsroom/barron_scholarship.htm



Calendar of Events



RECURRING



Arizona Hydrological Society (Flagstaff). 2nd Tuesday of the month (during the school year). Meeting times and locations may vary, NAU, Southwest Forest and Science Complex, 2500 S. Pine Knoll Dr., Room 136, Flagstaff. Contact: Abe Springer 520-523-7198, email: abe.springer@nau.edu

Arizona Hydrological Society (Phoenix). Usually 2nd Tuesday of the month, locations vary. Contact: Christie O'Day 602-379-3087, ext 224. cmoday@usgs.gov or beth.proffitt@worldnet.att.net

Arizona Hydrological Society (Tucson). Usually 2nd Tuesday of the month. Contact: Mike Block 520-575-8100 or mblock@metrowater.com

Arizona Water Banking Authority (Phoenix). Next quarterly meeting will be held on Sept. 13 at the ADWR in Phoenix. Contact: Nan Flores 602-417-2418.

Arizona Water for People Committee. Phoenix, meets on the 2nd Thursday of even-numbered months at City of Phoenix Squaw Peak Facilities, 6202 N. 24th St., Phoenix at 6 p.m. Contact Dave Christiana 602-417-2400, ext 7339; Tucson, meets the 3rd Thursday of even-numbered months. Time and place varies. Contact Sheila Bowen, 520-625-8409 or sbowen@communitywater.com

Arizona Water Protection Fund Commission. Contact: Irma Lisa Horton 602-417-2400 ext. 7016.

Arizona Water Resources Advisory Board. Phoenix, meets at the ADWR 10am to 12 noon. quarterly meetings aug 4 and nov 3. Contact: Bobbie Wood 602-417-2410. bjwood@adwr.state.az.us

Central Arizona Water Conservation District. Usually 1st and 3rd Thursdays of the month, time to be determined one week in advance. CAP Board Room, 23636 N. 7th St., Phoenix. Contact: Ardis McBee 623-869-2210. amcbee@cap-az.com

City of Tucson Citizens Water Advisory Committee. Usually 1st Tuesday of the month, 7:00-9:00 a.m., 310 W. Alameda, Tucson. Contact: John O'Hara 520-791-5080 ext. 1446.

Maricopa Association of Governments/Water Quality Advisory Committee. Contact: Lindy Bauer 602-254-6300.

Maricopa County Flood Control Advisory Board. Usually 4th Wednesday of the month, 2:00 p.m., 2801 W. Durango, Phoenix. Contact: Kathy Smith 602-506-1501 or kks@mail.maricopa.gov

Phoenix AMA, GUAC. Scheduled monthly, please call. Conference Room A, 500 N. 3rd St. Phoenix. Contact: Mark Frank 602-417-2465.

Pima Assoc. of Governments Environmental Planning Advisory Committee meets first Friday of every month at 9:30am 1:30pm., 177 N. Church St., Suite 405, Tucson. Contact: Claire Zucker 792-1903 czucker@pagnet.org.

Pima Assoc. of Governments Water Quality Subcommittee. Usually 3rd Thursday of the month, 1:30pm., 177 N. Church St., Suite 405, Tucson. Contact: Claire Zucker 792-1903 czucker@pagnet.org.

Pinal AMA, GUAC. Usually 3rd Thursday of the month, 2:00 pm. Pinal AMA Conference Room, 1000 E. Racine, Casa Grande. Contact: Randy Edmond 520-836-4857.

Prescott AMA, GUAC. 2200 E. Hilldale Rd., Prescott. Contact: Phil Foster 520-778-7202.

Santa Cruz AMA, GUAC. Usually 3rd Wednesday of the month, 9:00 am, Santa Cruz AMA Conference Room, 857 W. Bell Rd, Suite 3, Nogales. Contact: Kay Garrett 520-761-1814.

Tucson AMA, GUAC. Usually 3rd or 4th Friday of the month, 9:00 a.m., Tucson AMA Conference Room, 400 W. Congress, Suite 518, Tucson. Contact: Kathy Jacobs 520-770-3800.

Tucson AMA, Safe Yield Task Force. Every Wednesday. Contact Kathy Jacobs 520-770-3800.

Verde Watershed Association. VWA general meeting 3rd Tuesday of every month at various locations. Contact: VWA Newsletter Editor, Verde Watershed Association, 827 N. Main St., Cottonwood, AZ 86326; phone: 520-634-5526; message phone: 520-649-9978, email: verdewatershed@yahoo.com; website <http://vwa.southwest-water.org>

Water Users Association of Arizona. 2nd Friday of the month at noon (except in September). Call for reservations and exact location. Contact: Paul Gardner, 480-987-3240.

Yavapai County Flood Control District Board of Directors. Contact: Ken Spedding, 520-771-3197.

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United States Bureau of Reclamation
USGS Water Resources Division

Their contributions help make continued publication of this newsletter possible.

Aquaculture...continued from page 1

ciency with which fish convert grain into protein. Cattle require about 7 kilograms of grain to add one kilogram of live weight. Fish are able to add a kilogram of live weight with less than two kilograms of grain. Also, grain saved is water saved, since it can take 1,000 tons of irrigation water to produce one ton of grain.

Kevin Fitzsimmons, researcher at the University of Arizona's Environmental Research Laboratory, describes further ways that fish farming in Arizona encourages an efficient use of the state's limited water resources. He says that aquaculture and agriculture can be pursued together as complementary activities, with both operations sharing a single source of water. Water therefore is more intensely used.

Agricultural water is generally confined to ditches and canals, and water thus controlled and managed is suitable for fish farming. Adapting irrigation ditches to aquaculture might be as simple as installing screens in the ditches. Or it may involve a more sophisticated system of diverting irrigation water through dedicated tanks or raceways before the water flows to crops.

Further, the water from the fish farm operations contains uneaten feed and fish effluent rich in nutrients. This can be used to fertilize crops. Much of the nutrients in fish effluent is bound in solids or other complex organic forms. Thus nitrates within fish effluent do not migrate through the soil as rapidly as they do in chemical fertilizers. This lessens the chances of nitrates leaching into the groundwater. Also by using fish effluent as a fertilizer farmers are able to market their crops as organic.

ERL has conducted an aquacultural/agricultural research project at the Maricopa Agricultural Center, with water from a catfish pond irrigating a cotton crop. The Center and ERL are the most important sources of fish farming information and services in the state. The website <http://ag.arizona.edu/azaqua> highlights much of this information.

The efficient use of resources is not the only factor favoring the growth of aquaculture. Fitzsimmons says the demand for fish is increasing because people are consuming more seafood. For example, persons concerned about cholesterol are likely to substitute fish for beef. Also Asians and newly arrived Mexicans, two groups increasingly immigrating to Arizona, regularly include fish in their diets.

Although fish consumption is the prime reason for the increased growth of fish farming in Arizona, other developments also are encouraging the activity. Government agencies have been growing fish in hatcheries to stock lakes and ponds. The private sector, however, also has got involved in recreational fishing by raising fish to be released in a controlled fishing setting. Persons then pay to fish in these areas. Such operations have proven to be successful in Sedona and the White Mountains. Also a limited number of ornamental fish are grown in Arizona.

Aquaculture also can be used as a method to maintain water quality in human-made lakes and channels. For example, the Salt River Project and the Central Arizona Project use white amur in their canal systems to control moss and algae, which reduce flow rates and waste thousands of acre-feet of water every year. The amur are voracious weed eaters and can consume three quarters of their body weight in algae each day during the summer. This reduces the need for expensive machinery as well as the use of chemical herbicides.

Fitzsimmons expects fish farming to continue to grow and expand in the state, with more fish consumed and more farmers taking advantage of aquacultural opportunities. Arizona's location in the desert does not mean the state will not participate in the global aquacultural boom.

A copy of the WorldWatch report on aquaculture is available at www.worldwatch.org/alerts/indexia.html



Water Resources Research Center
College of Agriculture and Life Sciences
The University of Arizona,
350 N. Campbell Ave
Tucson, AZ 85721

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