New Waves
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A&M-Galveston Project to Test Use of Iodine Tracers to Date Ground and Surface Waters

A new method which utilizes radioactive isotopes to date surface and ground water supplies will be field tested in a research project funded by the Texas Water Resources Institute (TWRI). Project leaders include researcher Peter Santschi and graduate student Kathy Schwehr of the Marine Sciences Department at Texas A&M University-Galveston (A&M-Galveston) and Bruce Herbert of the Texas A&M University (TAMU) Geology and Geosciences Department.

The overall goal of the project is to test a method that will differentiate the sources of water in Texas aquifers. For example, it is important to know the relative volume of water recently introduced to aquifers through precipitation and runoff, compared with the amount of water which has existed in these hydrogeologic formations for some time. Gaining this information would yield critical insights into recharge rates for various aquifers and the likelihood that future rainfall may replenish groundwater supplies.

The research team will test the use of a particular species of Iodine (129-I) to see if it can be used to provide useful data about aquifer resident times of Texas groundwaters. The study site is the Gorman Cave, which is located in the Colorado Bend State Park near San Saba.

The theoretical framework for this project, Santschi says, is that 129-I is an ideal isotope for tracing and dating waters since it largely results from human activities such as nuclear weapons testing and reprocessing. Because nuclear weapons testing began roughly 50 years ago, waters with significant concentrations of 129-I are likely to be less than 50

years old. By comparing the levels of 129-I to a more stable, naturally occurring iodine isotope (127-I), the relative age of groundwaters can be determined.

According to Santschi, this method can be very useful in learning more about groundwater recharge rates. For example, waters which have been in aquifers for more than 50 years are likely to have small concentrations of 129-I, if any at all. Conversely, waters introduced by rainfall and runoff since the 1940s should have significant levels of 129-I, since this isotope is currently present in the atmosphere.

In this project, the research team will visit Gorman Cave to gather data on surface waters (rainfall and springs) as well as groundwaters (infiltrated cave waters which drip into pools and hydrogeologic formations). Because the cave may exhibit high levels of 129-I, 222-Radon, and 210-Polonium (which are also radioactive tracers), the site also lends itself to evaluation of these methods. Santschi believes that the use of 129-I may be useful to determine the relative age of surface and ground waters at many sites in Texas.

UH Studies Use of Filters to Treat Lake Houston Waters

Can the use of high-tech filtration methods provide safe disinfection for drinking waters taken from Lake Houston and other surface waters with water quality challenges?

That's one of the questions researchers at the University of Houston (UH) will try to answer in a project recently awarded by the Texas Water Resources Institute (TWRI). The lead researcher in this effort is Shankar Chellam of the UH Civil and Environmental Engineering Department.

The crux of the problem, Chellam explains, is that the water quality in Lake Houston has been characterized as having high levels of turbidity, organic carbon, and microorganisms. If tougher federal water quality standards for trihalomethanes, *Cryptosporidium*, and other parameters are enacted, Chellam says it may be difficult to meet these rules using existing treatment methods. For example, traditional treatment methods such as sand filters and chlorine are not effective at inactivating *Cryptosporidium* oocysts, which are egg-like structures, from water supplies.

As an alternative, Chellam will investigate three types of filtration methods which will be used in sequence to improve water quality. First, microfilters (which filter out particles larger than approximately 1 micron in diameter) and ultrafilters (which remove particles bigger than roughly 0.01 micron in diameter) will be used for pretreatment. The microfilters and ultrafilters will remove protozoans and bacteria. Waters will pass through a nanofilter (which removes particles larger than 0.001 micron in diameter) for final treatment. A micron is a unit of measurement equal to one-millionth of a meter. Experts say the diameter of an individual human hair ranges from 70 to 100 microns. *Cryptosporidium* oocysts are typically roughly 5 microns in diameter, while bacteria are often just 1 micron in diameter.

"A problem in disinfecting with chlorine, as has been traditionally done, is that it generates disinfection byproducts which some experts view as a potential health threat,"

Chellam says. "The appeal of using filters is that disinfection is accomplished through a purely physical basis, hence there are no adverse disinfection byproducts."

Initially, the researchers will collect water quality data from various parts of Lake Houston. Later, laboratory studies will be conducted to investigate which parameters in Lake Houston water are likely to foul or clog membranes used in filters, as well as the physical and chemical processes by which these filters remove contaminants. They will also study how storm events may affect the composition and distribution of pollutants which cause filters to foul. Chellam hopes to develop a mathematical model to predict the efficiency of various filtration strategies. Throughout the project, Chellam will work with the City of Houston Water Department professional staff. Houston is planning to begin pilot-scale studies about the use of filters to treat Lake Houston waters next year.

Creating a Three-Dimensional Groundwater Model for the Texas Coastal Bend

Researcher: Richard Hay, Center for Water Supply Studies, Texas A&M University-Corpus Christi, Corpus Christi, TX.

Problem: Regional water planning groups, working under Senate Bill 1 guidelines, need tools to simulate varying levels of water use. This includes the ability to simulate groundwater pumping from specific aquifers. For the semi-arid Coastal Bend region, this problem is particularly acute.

Objectives: To develop a three-dimensional, steady state, numerical groundwater flow model for the Texas Coastal Bend which can simulate pre-development conditions (aquifer levels prior to any pumping) and conditions under various pumping regimes.

Model Development: The target of this study is the Gulf Coast Aquifer, which underlies much of the Coastal Bend. The area covered in this project is shown in the accompanying figure. It stretches from the Gulf of Mexico to the boundary of the Jasper Aquifer and from the Navidad River to the Willacy County line. This system is complex and includes the Chicot Aquifer, the Evangeline Aquifer, the Burkeville confining unit, and the Jasper Aquifer. Data were obtained from raw and processed well information from the Texas Water Development Board (TWDB) and other sources. The TWDB well data were useful in aligning specific locations accurately onto the grid. Modeling tools which were used

include the U.S. Geological Survey MODFLOW finite-difference grid software as well as a geographic information system. A finite difference grid was created at a spacing of 10,000 x 10,000 feet. The grid consisted of 130 rows, 83 columns, 5 layers, more than 19,000 active cells, and 792 constant head cells. Recharge rates throughout the area were developed. The model was verified with 1985 heads and pumping data from the Kingsville and Victoria areas.

Results: The model was used to calculate groundwater availability in each county in the region. Results show that each county in the study area, except Duval and Live Oak, has sufficient groundwater to meet projected needs over the next 50 years. A transient model may help better estimate water availability in these counties. In general, the model presents a good statistical fit for many areas. Perhaps most importantly, the model should allow water planners to ask "what if" questions to learn how various water uses may affect long-term groundwater levels. The model is being made available to regional planning group members and will be used to help craft water development strategies for the area. The model may have to be refined in the southern part of the region to better reflect a no-flow boundary.

Reference: Hay, R., "A Numerical Groundwater Model of the Gulf Coast Aquifer: Coastal Bend Region, Texas," Presented at The Southwest Focus Groundwater Conference 2000, National Ground Water Association, Austin, TX.

Estimating the Vulnerability of the Paluxy Aquifer to Pollution using DRASTIC and GIS

Researchers: Todd Fritch, Cleavy McKnight, and Joe Yelderman, Geology Department, Baylor University, Waco, TX; and Jeff Arnold, United States Department of Agriculture Research Service (USDA/ ARS), Temple, TX.

Problem: The Paluxy Aquifer, located in north central Texas, provides a source of water for domestic and agricultural use. To assure that this aquifer can continue to be used as a water source in the future, it is essential to estimate whether certain locations in this groundwater formation may be vulnerable to pollution. This information can then be used to develop long-term pollution prevention strategies, and to assess the likely impact of proposed land use practices. Procedures like DRASTIC (a method to evaluate the likelihood that an aquifer may become contaminated) and geographic information systems (GIS) need to be tested to determine if they may be useful in evaluating potential pollution risks.

Objectives: To evaluate the combined use of DRASTIC and GIS as a method to better predict groundwater pollution risks in the Paluxy Aquifer, and to identify if improvements to either of these methods need to be made.

Methods: DRASTIC is an acronym for a technique which can be used to estimate the pollution potential of aquifers. In this strategy, information is obtained on Depth to groundwater, net Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone, and Conductivity of the aquifer. Typically, DRASTIC has been used to

investigate the pollution potential of a region, rather than individual locations. This project explored the groundwater pollution risks faced by the Paluxy aquifer and its recharge zone. Geographic boundaries were obtained from U.S. Geological Survey digital line graphs, the USDA Natural Resource Conservation Service STATSGO soils database, and *The Geologic Atlas of Texas*, which is produced by the Bureau of Economic Geology at the University of Texas at Austin. This data was digitized and assembled in a GIS using GRASS software at the USDA Blackland Research Center at Temple. When conducting the DRASTIC analysis, the researchers tried to better calculate recharge values by incorporating data about how streamflows recharge the aquifer. They worked to better characterize the vadose zone by closely examining the geology of the outcrop of the aquifer, the thickness of materials overlying the aquifer, and the condition of the aquifer material.

Results: This study resulted in a product which can calculate the groundwater pollution risk at any specific site in the study area. Because the data resides in a GIS, queries can easily be made to ask "what if" scenarios. Results of this investigation yielded new insights on how vulnerable this aquifer may be to contamination, compared to previous methods. For example, only 11% of the area was ranked as a high pollution risk (based on old estimates), while the new method suggests that twice that amount may be prone to contamination. While the old techniques suggested that 71% of the region had only a low pollution potential risk, use of this new strategy implies that only roughly half of the region (47%) may exhibit a low vulnerability to pollution.

Reference: Fritch, T., C. McKnight, J. Yelderman, and J. Arnold, "Environmental Auditing: An Aquifer Vulnerability Assessment of the Paluxy Aquifer, Central Texas, Using GIS and a Modified DRASTIC Approach," *Environmental Management*, Vol. 25 (2000): 337-345.

Estimating the Value of Rio Grande Water Mexico Has Not Delivered to the United States in the 1990's

Researchers: Mickey Wright and Daniel Hardin, Texas Water Development Board (TWDB), Austin, TX; Lonnie Jones, Agricultural Economics Department, Texas A&M University, College Station, TX; and John Robinson, Texas A&M University Agricultural Research and Extension Center, Weslaco, TX.

Problem: Under the terms of a 1944 Treaty, Mexico is obligated to deliver at least 350,000 acre-feet (AF) of water from its tributaries to the Rio Grande annually. However, Mexico has not delivered the required amount of water throughout much of the 1990s. As a result, there has been less water available to users on the United States side of the border, especially agricultural interests which are widespread throughout the Lower Valley. The regional water planning group in this area, working under Senate Bill 1, requested that TWDB and Texas A&M assess the economic ramifications of these shortfalls.

Objectives: To develop estimates of the direct and indirect economic effects which Texas has suffered, as a result of Mexico delivering less water than required to the Rio Grande.

Methods: The study spanned the period from 1992 through 1999 and developed a cumulative estimate of economic damage. This was done because, in the absence of sufficient flows from Mexico, farmers were still able to get some of the water needed by asking for releases from Amistad and Falcon Reservoirs. However, by the end of this period, water levels in these reservoirs had been substantially drawn down and now less water is available. The approach used in this project involved estimating "opportunity costs" (in this case, lost economic opportunities that would have been available if an adequate amount of water had been delivered). Direct impacts of irrigation practices on the regional economy were projected by estimating the value of crops typically grown in the region which can be produced with an AF of water and multiplying that value by the total number of acres in production. It was assumed that farmers would grow higher value crops, if adequate water supplies were available. Indirect impacts were derived by estimating how irrigation affects the broader economy in the region, including business activity, employment, and income of farmers.

Results: The annual direct impact of lost opportunity costs due to insufficient water deliveries from Mexico was estimated to be $507 per AF, while the indirect impact was estimated at $710 per AF per year. This translate into losses of roughly $400 million annually. It should be noted that more detailed studies need to be conducted to pinpoint year-to-year losses as well as decreases in particular crop mixes.

Reference: Robinson, J., L. Jones, M. Wright, and D. Hardin, "Economic Analysis Value of Applied Irrigation Water and Its Impact on the Rio Grande Water Planning Region," Special Report published by the TAMU Research and Extension Center in Weslaco, March 2000.

Analyzing Why Texas Has Failed to Develop and Implement a River Protection Policy

Researchers: Michelle Petit, Institute of Applied Sciences, and F. Andrew Schoolmaster, Geography Department, University of North Texas, Denton, TX.

Problem: Roughly 90% of the 3.5 million miles of rivers in the United States have been altered for such purposes as flood control, navigation, irrigation, water supplies and hydropower. To preserve the remaining 10% of river miles, Congress passed the National Wild and Scenic Rivers Act in 1968. Similarly, many states have also enacted strong river protection programs. Texas is notable in that it is one of a handful of states which has not crafted a program to preserve wild and scenic rivers. Additionally, Texas ranks second only to Minnesota in the total surface miles associated with rivers and inland waterways. Examining successful programs, both at the federal level and in other states, may yield valuable ideas about policies that may succeed in Texas.

Objectives: To assess characteristics of federal and state river protection programs and to examine why Texas has failed to pass a river protection strategy.

Background Information: According to the 1995 National Rivers Inventory, more than 80,000 river miles qualified for wild and scenic designation, although fewer than 10,000 river miles had actually been enrolled. As of December 1996, 32 states (most in the East) had enacted river protection legislation programs. These efforts are largely absent in such Great Plains states as Texas. Location quotient analysis was used to determine the extent to which individual states have protected river reaches, compared to national efforts. In general, results show that state efforts to protect streams from development are largely lacking in the Great Plains. Efforts were also made to identify key components of successful state river protection programs. This includes procedures to designate and classify rivers to be protected, the level of protection offered for designated stream segments and riparian lands, whether opportunities for participation by local citizens and riparian landowners were offered, and the presence of state and local management and funding. Using these parameters, Texas experiences with failed attempts to develop a river protection program were evaluated.

Discussion: In general, efforts to protect Texas rivers from development have failed, although a 191-mile segment of the Rio Grande was designated as a federal Wild and Scenic River in 1978. Between 1969 and 1995, nine unsuccessful initiatives were proposed in the Texas Legislature. Early measures proposed to protect a large number of rivers, to restrict the use of riparian lands, to subsidize the condemnation of private lands, and to provide for the designation of additional rivers in the future. The authors contend that Texas' unique political, cultural, and social environment has promoted water development and fostered resistance to river protection initiatives. For example, more than 92% of the land in Texas is allocated for agricultural uses, which are generally opposed to programs which attempt to control rivers and nearby lands. In addition, because much of Texas is arid, there has often been tension between state and local agencies which promote water development and those who, by urging that rivers and streams be kept in a natural state, are opposed to dam-building and related measures. As alternatives, the authors suggest that programs that may succeed in Texas include local initiatives to protect greenways and river corridors, and providing state assistance to create, develop, and manage these programs. Specific elements that should be considered include measures to protect riparian lands, to monitor river recreation, and to safeguard urban stream corridors. Factors which have been successful in other states that may work in Texas involve programs to assist riparian landowners, increasing support by the public and the Legislature, and linking these efforts to river protection programs.

Reference: Petitt, M., and F. A. Schoolmaster, "Developing a River Protection Policy for Texas -- Paddling Upstream Against the Current," *Applied Geographic Studies*, Vol. 1 (1997): 187-205.

Using Airborne Surveys to Assess Groundwater Resources in the Lower Rio Grande Valley

Researchers: Jeffrey Paine, Bureau of Economic Geology, Austin, TX; and Edward Angle and Rima Petrossian, Texas Water Development Board, Austin, TX.

Problem: The Lower Rio Grande Valley is expected to experience sharp increases in water demands over the next 50 years. Currently, the Rio Grande supplies roughly 97% of the water being used by municipalities, agriculture, and industries in the region. To meet future needs, water planning groups, operating under Senate Bill 1, want to investigate the extent to which groundwater resources in the region can be a viable alternate supply source. The use of airborne surveys is a strategy which can be used to gather key data on groundwater quality and other aquifer characteristics.

Objectives: To determine, through field testing, if the use of airborne surveys can be used to generate accurate, reliable information about groundwater resources in the Lower Rio Grande Valley.

Methods: The concept tested in this project is that electromagnetic induction (EM) methods detect changes in the electrical conductivity of the ground which are caused by variations in geology, water saturation, and water chemistry. Because water-bearing sand and clay formations are likely to have differing electrical conductivities, the researchers hypothesize that EM methods can be used to identify variations in geology and water quality over large areas to depths of roughly 200 meters (m). Two test sites were chosen (the Faysville area in Hidalgo County and the Stockholm area near the boundary of Willacy and Cameron counties). Aerial surveys were conducted in August 1999 for the Stockholm area and October 1999 for the Faysville area. Airborne EM data collected during these surveys revealed information about the electrical properties of the ground. In both surveys, twin-engine aircraft flew at an altitude of 120 m. The planes flew transects consisting of north-south lines spaced at 400 m and east-west lines spaced at 4 kilometers (km). The planes carried a time-domain transmitter and recorded the ground's response using a towed receiver, which flew about 70 m above the ground. The airborne data were compared to other sources, including well records, water quality information, and results from similar ground-based instruments. Data were mapped and incorporated into a geographic information system (GIS) to help select potential sites with good water quality

Results: Preliminary results suggest that this method was able to successfully gather electrical conductivity data that correlate reasonably well to total dissolved solids concentrations in samples from area water wells. The research also shows that airborne EM is a viable strategy to gather aquifer information in the Lower Rio Grande Valley within the upper few hundred meters. Integrating data from this project into a GIS can also provide readily understood information regarding lateral changes in water quality. For example, the researchers have developed color maps and computerized animation showing variations in conductivity (and thus likely water quality) at varying depths within the study areas. This information will be used to identify sites and depths where

new wells should be drilled, or to monitor whether changes in water quality, like saltwater encroachment, may be occurring.

Reference: Paine, J., E. Angle, and R. Petrossian, "Identifying and Assessing Ground Water in the Lower Rio Grande Valley, Texas, Using Airborne Electromagnetic Induction," paper presented at Southwest Focus 2000 Conference, National Ground Water Association, Austin, TX.

TAES and Israeli Scientists Work to Develop Commercial Production of Edible Sea Urchins

Edible sea urchins, which are harvested for their gonads, are in great demand in Japan, Southern Europe, and many other areas. The demand for these sea urchins is so great that it is exhausting natural sea urchin populations. As an alternative, there has been interest in commercially raising sea urchins in a land-based mariculture facility.

Currently, Addison Lawrence of the Texas Agricultural Experiment System (TAES) and Muki Shpigel of the Israel National Center for Mariculture (INCM) are working together to investigate how diets may influence sea urchin production. The research team is studying the effect of environmental factors such as photoperiods (exposure to light) and water temperatures on growth and development.

Lawrence is researching nutrition sources which could be developed and produced in Texas, including extruded feeds derived from pelleted grains. This feed will be tested in Israel where a species of sea urchin (*Paracentrotus lividus*) is being grown in mariculture operations. During the past two years, Israeli researchers have produced 20,000 adult sea urchins, which are being grown in a pilot-scale system. Shpigel will test the feeds to learn if they increase gonad production.

According to Lawrence, this experiment may help create an additional market for grains. "Exporting these feeds would help to diversify Texas, agriculture base," said Lawrence, "and be a new source of income for the state." Sea urchin production facilities could be developed in Texas, based in part on experiences gained in this project.

Funding was provided by the Texas Department of Agriculture. For details, contact Lawrence at smpall@electrotex.com or (361) 749-4625.

Lamar University Research Studies Movement of Nutrients, Saltwater, Through Sabine Lake Ecosystem

A Lamar University scientist is researching the movement of saltwater and nutrients going to and from Sabine Lake and nearby marshes. The study is led by Xing Fang of the Civil Engineering Department. It is funded by the Texas Water Development Board (TWDB).

Several factors have contributed to the need for this project, Fang says. First, Sabine Lake is located on the Texas-Louisiana border and receives more freshwater per unit volume than other Texas bays. Second, Texas and Louisiana share Sabine Lake. As a result, there are concerns that water withdrawn from the lake by Texas may adversely affect estuaries in Louisiana which border this waterbody. In addition, some fresh water which would normally enter the lake is intercepted by the Texas Ship Channel which borders Sabine Lake. As a result, it is difficult to know for sure just how much water is really in the lake.

In theory, biologic production from deltas and marshes makes the estuary more productive. Studies by the Texas Parks and Wildlife Department suggest that the east side of the lake, which borders Louisiana, may be more rich biologically than the part of the lake which borders Texas. It is has been hypothesized that biological production from the marshes is more important to the lake's health than the nutrients brought from the Sabine and Neches Rivers, which flow into the lake. Data from this research may provide a means to characterize the contribution of the marsh to the lake's health.

In this project, salinity and other water quality parameters are being monitored in two bayous connecting Sabine Lake to nearby marshland. Salinity data will be gathered by automated instruments. This information will allow researchers to deduce relationships between inflows and salinities in these bayou so that mathematical models of the lake can be created. Nutrient transport will be studied by measuring flows as well as dissolved and suspended nutrients in the target bayous. The water quality data collected in this project will be entered into an analytical modeling project that will create a nitrogen budget for the lake. This budget may be used to compare nutrient contributions from the Sabine and Neches rivers to discharges from municipal wastewater treatment plants.

For details, contact Fang at (409) 880-2287 or fangxu@hal.lamar.edu.

UTMB, A&M-Galveston, Team Up To Help Oysters Spawn in Aquaculture Operations

Aquaculture has been proposed as a possible solution to many problems facing the oyster industry in Texas and elsewhere. Currently, there are concerns that adverse environmental changes (such as pollution, increases in global temperatures, and heightened salinities) may make it more difficult for oysters to survive in Texas bays and estuaries. At the same time, many experts fear too many oysters are being taken from Texas bays, and that this resource is being over harvested.

In response to these concerns, a team of researchers from the University of Texas Medical Branch at Galveston (UTMB) and Texas A&M University-Galveston is investigating the use of a method that may make oyster production more viable in aquaculture operations. The research is led by Gregg Nagle and Sherry Painter of the UTMB Marine Biomedical Institute and Sammy Ray of the Marine Biology Department at A&M-Galveston. It is being funded by the Texas Higher Education Coordinating Board.

The studies involve investigate whether *Crassostrea virginica* oysters contain a peptide or protein pheromone which could be used in oyster aquaculture. Initially, the researchers plan to extract peptides and proteins from male gonads of these oysters. Each month, Ray gathers as many as 270 oysters from the Galveston Bay area, tests them for pathogens, and removes the male gonads. Nagle and Painter then try to identify the peptides or protein pheromones used to induce spawning. Later, Nagle and Painter will produce a synthetic or recombinant peptide which will be bioassayed and verified at A&M-Galveston.

"If the pheromone is a success, we expect to develop a spawning kit for commercial use in Texas and the United States, " Nagle said. "Aquaculture of oysters is not economically competitive with commercially-harvested oysters at this time, but may be in the future. This project is a potential long-term solution."

If a suitable pheromone can be produced synthetically, it could be incorporated into a spawning kit which could trigger spawning in male and female adult oysters on demand. This pathogen-free spawning kit could simplify and standardize oyster aquaculture and could allow for genetic manipulation for selective breeding. The researchers are also investigating growing oysters with treated wastewater from shrimp farming. This could provide a nutrient-rich water supply for oysters as well as a method to treat effluents generated by shrimp aquaculture.

Texas A&M Researcher Studies Use of Hedging Strategies to Keep Texas Ports Economically Competitive

International shipping is vitally important to the Texas economy. For example, the Port of Houston ranks fourth nationally in the total dollar value of goods shipped and generates jobs, revenues, and taxes. Keeping freight rates competitive is an essential component of global trading.

Currently, Michael Haigh of the Texas A&M University Agricultural Economics Department is researching the effectiveness of using ocean freight futures contracts for hedging international freight price risks associated with exports of grains and oilseeds from Texas ports. The project is funded by the Texas Higher Education Coordinating Board.

Haigh explains the notion of hedging is to decrease price risk by taking an equal and opposite position in futures or option markets from ones taken in the cash market. Hedging allows the buying and selling of contracts on ocean shipping. "The idea is that the hedge eliminates the uncertainty associated with unknown future shipping rates that might reduce profits or even create losses, " Haigh explained.

In this study, Haigh is developing a computer simulation model that examines how grain traders might choose to ship goods through various ports. The simulation model will allow researchers to compare the effectiveness of hedging between different ports. By using this simulation tool, Haigh can test the ability of shippers to hedge risks associated with freight prices across different ports and learn if uncertainty and variability of profits can be reduced. Ultimately, Haigh says, decision-making tools like this may improve the marketability and attractiveness of Texas ports and enhance stability for Texas, exported grains and oilseeds.

For details, contact Haigh at mshaigh@tamu.edu or (979) 845-5819.

SWT Researchers Work to Restore Aquarena Springs

Through 1984., when Southwest Texas State University (SWT) acquired the site, Aquarena Springs was a theme park. Now, a team of biologists at SWT is creating a vastly different plan for this area. Researchers are now restoring the area's natural environment, and are finishing work on a wetlands center which will enhance environmental education. The project is led by Tom Arsuffi, Paula Williamson, and Francis Rose of the Biology Department.

This project features two major components. First, exotic animals (like geese and nutria) as well as plants (like floating water hyacinth) are being removed to the maximum extent possible. For example, Williamson estimates that as many as 500 people have taken part in efforts to pull water hyacinths out of Spring Lake by hand. In addition, large numbers of exotic trees such as Chinese tallows and legustrums were also removed. Meanwhile, Rose reports that populations of non-native swans, geese, and nutria have also been lessened (these animals were placed in other accommodations). Ultimately, the goal is to

replace exotic species with natural counterparts. Arrowhead or forest tail are macrophytes (or grasses) being considered as candidates to grow along riverbanks to lessen erosion once non-native elephant ears are removed.

Already, Williamson says, the efforts to remove exotic plants are paying off in terms of increased growth of fanwort, eelgrass, and other submerged plants.

The project also involves developing and installing an environmental educational boardwalk. The boardwalk will take learners through riparian, emergent, and open environment wetlands habitats. Interpretive signs posted along the boardwalk will describe ecological processes which occur in wetlands, the importance of restoring and preserving habitats, and the significance of endangered and threatened species in San Marcos Springs. Arsuffi says this project will benefit the University and the public in many ways. It fits well into SWT's plans to use the site for research in environmental and aquatic ecosystem research. It will also provide opportunities for ecotourism and environmental education.

TAES, USGS, Team Up to Study Agricultural Runoff, Contaminants in Rainfall, in Coastal Bend Region

Researchers with the Texas A&M University Agricultural Research and Extension Center in Corpus Christi have recently completed two studies of water resources and environmental issues in the Texas Coastal Bend region.

In one study, Bobby Eddleman of the Texas Agricultural Experiment Station (TAES) led efforts to measure the quality of surface water runoff from agricultural croplands in the Odem Ranch watershed. This work was funded by a grant from the Corpus Christi Bay National Estuary Program (CCBNEP). The investigation consisted of gathering and analyzing water quality data from seven storm events between 1996 and 1999. Three of these storms occurred during the growing season for agricultural crops. Another storm struck the area immediately after harvest, while three others hit in the fall when fields are bare. In general, results of this project suggest that concentrations of all forms of nitrogen and phosphorus, as well as many pesticides, in runoff were less than water quality standards developed by the Texas Natural Resource Conservation Commission to protect human health and

aquatic life. Eddleman says links could not be made between the months of the year during which crops were produced, the timing of applications of nutrients and pesticides to croplands, and seasonality of stormwater runoff and differences in nutrient and pesticide loads in runoff.

In a related study, Clinton Livingston of TAES and Darwin Ockerman of the United States Geological Survey (USGS) worked to measure and analyze nitrogen concentrations and deposition in rainfall at two sites in the Coastal Bend near Kingsville and Edroy. This project was funded by the Texas State Soil and Water Conservation Board. Data were gathered on 39 rainfall events from 1996 to 1998, and were analyzed for dissolved nitrate-nitrogen, dissolved nitrite-nitrogen, dissolved ammonia, total and dissolved ammonia plus organic nitrogen, and total nitrogen. A goal was to compare the relative proportion of nitrogen contributed directly by rainfall to levels that run off from various land uses. Results suggest that croplands served as sinks for nitrogen and phosphorus levels in rainfall. Five times more nitrogen and roughly twice as much phosphorus were deposited annually in rainfall than exited the watershed in runoff from storm events.

Note: *Assessment of Surface Water Quality from Agricultural Croplands in the Odem Ranch Watershed*, co-authored by Eddleman and Larry Falconer, was published by CCBNEP in February 2000. It can be obtained by contacting CCBNEP at (361) 825-6245. *Nitrogen Concentrations and Deposition in Rainfall at Two Sites in the Coastal Bend Area, South Texas, 1996-98*, co-authored by Ockerman and Livingston, was published by the USGS in December 1999 as FS-146-99. It can be obtained by calling the USGS at (210) 321-5200. Eddleman can be contacted at (361) 265-9201 or b-eddleman@tamu.edu.

Updated TWRI Publication List Is On the WWW

The 2000 updated version of the publications catalog of the Texas Water Resources Institute (TWRI) can now be downloaded from the World Wide Web (WWW) as an Adobe Acrobat pdf file. The publications list updates technical reports, conference proceedings, and newsletters published by TWRI, and contains ordering information. Other recent publications from TWRI include an issue of the *Texas Water Resources* newsletter discussing small watershed dams and new issues of the *Texas On-Site Insights* and *Texas Water Savers* newsletters. Finally, TWRI offers free e-mail list servers which send timely information directly to readers on request.

A&M Historial Pens Book on How Anglos Relate to Nature

A Texas A&M University (TAMU) historian has recently written a book describing how English-speaking settlers in the United States, Canada, Australia, and New Zealand looked at nature in their new lands.

Nature and the English Diaspora was written by Thomas Dunlap of the TAMU History Department. The book describes the development of natural history in these nations, how settlers adapted to new natural conditions, and the rise of environmentalism.

The book was published by the Cambridge University Press, whose World Wide Web site is http://www.cup.org. Dunlap can be contacted at t-dunlap@tamu.edu or (979) 845-7107.

UT Press Books Describe History of Springs, Environmental Issues

The University of Texas Press has published a new book which discusses Texas water resources and environmental issues

The Texas Environmental Almanac (2nd Edition) is a 386-page book compiled by Mary Sanger and Cyrus Reed of the Texas Center for Policy Studies in Austin. This book provides detailed information about water resources as well as issues related to air quality, waste management, and many related topics.

Another new UT Press book is *Taking the Waters in Texas - Springs, Spas, and Fountains of Youth.* This 288-page book was written by Janet Valenza, who teaches geography at colleges in the Austin area. The book describes the widespread use of springs and natural spas throughout Texas in the 1800s. It focuses on how springs were used for medical healing during that time.

For details on these books or to order, visit the University of Texas Press World Wide Web site at http://www.utexas.edu/utpress or call (800) 252-3206.

Marine Mammals of the Gulf of Mexico, History of Submarines, Featured in New TAMU Press Books

The Texas A&M University (TAMU) Press has published new books related to the biology of the Gulf of Mexico and the history of submarines.

Marine Mammals of the Gulf of Mexico was co-authored by Bernd Wursig of the TAMU Marine Mammal Stranding Network, Thomas Jefferson of Clymene Enterprises, and David Schmidley of the Research and Graduate Studies Office at Texas Tech University. The book provides a checklist of the species which are often found in the Gulf as well as keys to help identify them. It also discusses environmental problems which may affect mammals in the Gulf.

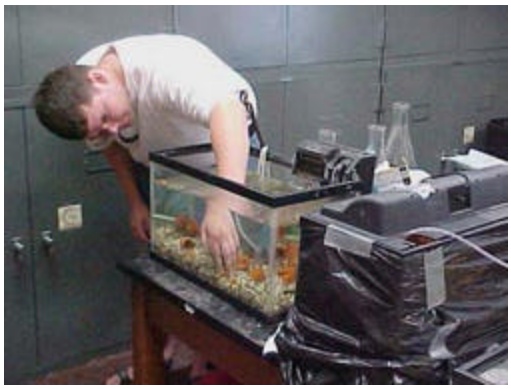
Argonaut: The Submarine Legacy of Simon Lake was written by John Poluhowich, a researcher in the Biology Department at West Texas A&M University. This book describes Lake's efforts to pioneer the design and construction of submarines.

For more information or to order, contact the TAMU Press by visiting their World Wide Web site at http://www.tamu.edu/upress or by calling (800) 826-8911.

Tarleton State Biologists Track Spread of Mud Crab in Central Texas Reservoirs

A mud crab which typically inhabits coastal waters has recently been showing up at Central Texas reservoirs. Because this crab is a nuisance, biologists from Tarleton State University are busily tracking how far the crab has spread and whether it's likely to invade more lakes.

The studies are being led by researcher Donald Keith and graduate student Harvey Richey. According to Keith, this species of mud crab (*Rhithropanopeus harrisii*) was first sighted in inland waters of Texas in 1998 at Possum Kingdom Lake. Since that time, it's been reported at three other lakes -- E. V. Spence, Colorado City, and Tradinghouse Creek. The growth of crab populations at Possum Kingdom has been rapid. Keith says that hundreds of individuals can be found at a single site during summer months, including very small juveniles and egg-bearing females.



Why should anyone care if the mud crabs become pervasive? According to Keith, the crabs are small enough that they can clog submersible pumps, and are invading water intake structures of lakeshore homes. If the problem grows, it could be similar to difficulties created by the zebra mussel in northern lakes.

Keith says part of the mystery is how the mud crab is able to survive in these inland lakes, which exhibit lower salinities than levels larvae typically are able to survive in. He believes that Central Texas mud crabs may represent a population which has adapted to local salinities.

Studies now underway at Tarleton involve laboratory attempts to breed the mud crabs so that the saltwater tolerance of larvae can be investigated. At the same time, mud crabs are also being gathered from both inland lakes and coastal waters throughout Texas. If the tolerance of larval crabs to low salinities in Possum Kingdom is significantly lower than that of larval crabs found in coastal waters, DNA analysis will be performed among both groups to attempt to establish genetic differences between these two populations. Ultimately, Keith hopes to use these data to predict the likelihood that mud crabs may invade other freshwater habitats in Texas.

For details, contact Keith at (254) 968-9153 or dekeith@tarleton.edu.

SFA Studies Ways to Remove Trees While Protecting Streams

Land managers in East Texas are concerned with the effects of forestry management practices on water quality in the region's streams. Best management practices are often employed to ensure that sediments don't run off into creeks and bayous. Recently, researchers and graduate students at Stephen F. Austin State University (SFASU) got the opportunity to take part in a unique study. They helped evaluate the aftermath of a severe windstorm which damaged more than 70,000 forested acres (roughly enough lumber to build 15,000 three-bedroom homes). It was feared fallen trees from this storm may pollute nearby waterbodies.

The research was led by Jack McCullough of the SFASU Environmental Sciences Program. Graduate students who took part include Brandon Swain (who studied Martinez and Brittain creeks), Selena Martin (who investigated Siep Creek and Blue Bayou), and Kenneth Moore (who studied Cypress Creek).

According to McCullough, soon after the storm hit resource managers had to decide if the fallen timber should be removed from forest lands as well as streams and creeks. Later, the United States Forest Service decided the best course of action was to remove as many of the fallen trees from the land to protect further damage to endangered species habitat and to prevent catostrophic wildlfires. The agency chose not to remove fallen timber from riparian areas (including streams) because it was thought that the process of moving heavy equipment to these areas might degrade water quality. The majority of the fallen timber was resting across the streams and did not greatly restrict normal flows. When timber was taken away from ecologically sensitive areas, helicopters were employed take away logs in order to lessen the effects of erosion.

The research team monitored several creeks where large amounts of woody debris had accumulated. The creeks were regularly sampled to gather data on fish and other aquatic organisms, water chemistry, and water quality. McCullough says that this study suggests that creeks where large amounts of trees had fallen did not suffer from worsened water quality. The data suggests these creeks may have had enhanced biological productivity, in large part because the fallen trees provided habitat and nutrients for benthic organisms.

For details, contact McCullough at (409) 468-6911 or jmccullough@sfasu.edu.

Texas A&M Literature Search Examines Environmental Issues Associated with Poultry Production

Current methods to gauge the effect of poultry and animal wastes on water resources and the environment may be inadequate, according to a new literature review prepared for the Texas Water Resources Institute (TWRI). The report, "Occurrence and Methodology for Monitoring Foodborne *Salmonella Spp.* In Poultry Waste Streams," was prepared by researcher Steven Ricke and graduate student Kristin Medvedev of the Texas A&M University Poultry Science Department. Much of the document discuss such issues as how intensive animal production may affect the environment. The report also explores the physiology of *Salmonella* in the environments where large amounts of waste are present, as well as the extent to which this organism acts as a pathogen.

Ricke says the study was prompted by concerns associated with the emergence of intensive agricultural operations in the Brazos Valley and much of Central Texas. "The jury is still out on how persistent *Salmonella* and other components of animal waste may be in rivers and streams and the environment," he said. "To really answer that question, we need to pinpoint the many different sources of fecal bacteria and the relative contributions of intensive animal operations to this problem."

According to Ricke, one of the challenges is that most of the studies performed on *Salmonella* to date have emphasized food quality concerns. For example, how can this organism be controlled to ensure eggs and meat are not contaminated? However, much less work has been done to learn how long *Salmonella* survives in areas where poultry litter and livestock waste are concentrated or land applied, or in rivers or streams which may receive runoff from these activities. In addition, the human health threat posed by *Salmonella* in the environment needs to be examined in greater detail.

Ricke also suggests there are promising new methods on the horizon which may help identify whether animal wastes are present at specific sites. "Molecular methods may be very valuable because they may be able to trace waste products to a particular host organism, including chickens, other animals, or even human wastes. Although it is now difficult to identify the source of fecal pollution problems, the use of molecular methods may reveal why contamination is occurring."

Before these more precise techniques can be used to target pollution sources, Ricke says major obstacles still have to be overcome. Key among them is finding a viable indicator

of pollution which is specific to poultry, and then learning how to culture that organism in a laboratory.

Ultimately, Ricke says, the goal is to provide science-based information which producers can use to grow animals in concentrated settings, while protecting natural resources. "We hope that we can help foster environmentally responsible concentrated poultry and animal production in the Brazos Valley and elsewhere," he said.

TWRI Funds Six Multidisciplinary Research Teams

Typically, it's difficult, if not impossible, to bring faculty together from different academic departments to tackle cross-cutting natural resources and environmental problems. The problem is even worse if you try to bring together more than one university to solve an environmental dilemma. For example, if runoff pollution of rural streams and lakes is a concern, how do you fully investigate that issue without involving biologists, engineers, political scientists, social scientists, and water quality professionals?

To address these concerns, the Texas Water Resources Institute (TWRI) recently began an initiative to provide start-up funds for interfaculty research teams. The idea, TWRI Director Wayne Jordan says, is to begin a process in which outstanding researchers can collaborate to create centers of excellence. "We have two major purposes in mind with this program," Jordan says. "First, there are many environmental issues that really need to be examined in a multidisciplinary approach, since the problems are so broad. Second, we hope that by bringing together research teams to investigate high priority issues, we can lay a groundwork to attract large grants from prominent funding organizations."

In June 2000, TWRI announced that six research teams had been selected for funding. These groups will be supported by TWRI through August 31, 2001. Some of the activities that will be carried out by these teams include the development of thorough literature searches, bringing scientists together with agency leaders and policy makers, and supporting graduate students.

The research teams funded by TWRI are listed below. Scientists are affiliated with Texas A&M University unless noted otherwise. In future issues of *New Waves*, we will describe the activities of these groups in more detail.

"Rapid Risk Assessment of Watersheds and Dams Using Geographic Information Systems and Modeling," Ranjan Muttiah and Raghavan Srinivasan (Texas Agricultural Experiment Station Blackland Research Center at Temple), Jeff Arnold (U.S. Department of Agriculture Research Center at Temple), Peter Allen, John Dunbar and Joseph White (Baylor University Geology Department), and Marty Matlock (Agricultural Engineering Department).

"Integration of Ecological, Economic, and Social Systems: Adaptive Management of Two Contrasting Texas Watersheds," William Grant, Frances Gelwick, William Neill, Daniel Roelke, R. Douglas Slack, (Wildlife and Fisheries Sciences Department), Marty

Matlock (Agricultural Engineering Department), Charles Samuelson (Psychology Department), Richard Woodward, (Agricultural Economics Department), and Arnold Vedlitz (Political Science Department). This work will be coordinated though the Center for Public Leadership Studies and the George Bush School of Government and Public Service.

"A Multi-Institutional Program for Enhancing Marine Fishery Resources through Aquaculture," Delbert Gatlin, William Neill, and John Gold (Wildlife and Fisheries Sciences Department), Todd Anderson (San Diego State University Biology Department), Miguel Angel Cisneros-Mata (National Fisheries Institute, Mexico), and Alejandro Buentello (Northwest Biological Research Center, Mexico)

"Low Cost Electron-Beam Remediation of Water and Wastewater," Peter McIntyre (Physics Department), Bruce Herbert (Geology Department), and Bill Batchelor (Civil Engineering Department).

"Creating a Faculty Incubator Group to Encourage Distributed Water Processing and Recycling in Oil and Gas Operations," David Burnett, Maria Barrufet, Duane McVay, and Steve Holditch, (Petroleum Engineering Department), Sefa Koseoglu and Ray Anthony (Chemical Engineering Department), and Bill Batchelor (Civil Engineering Department).

"Genosensor Based Approaches for Characterizing Microbial Populations and Identifying Horizontal Gene Transfer Events in Natural and Man-Made Environments," Suresh Pillai and Steven Ricke (Poultry Science Department), Peter McIntyre (Physics Department), and Dale Whittaker (Agricultural Engineering Department).

A&M-Galveston, TNRCC, Create WWW Site About Galveston Bay Issues, Research

Texas A&M University-Galveston and the Texas Natural Resource Conservation Commission (TNRCC) have created a World Wide Web (WWW) site with information about many issues related to Galveston Bay. The website focuses on scientific research projects funded by the Galveston Bay Estuary Program (GBEP), which works to study water quality and biological issues in the region. The website is hosted by A&M-Galveston. The address is http://gbep.tamug.tamu.edu.

Some of the items which can be found here include the 5-year plan for Galveston Bay as well as summaries of many research projects funded by GBEP. For example, the plan identifies priority problems and will develop strategies to preserve the Bay in the future. Some of the topics of GBEP - funded research and extension efforts involve populations of aquatic species, protection of species and habitats, freshwater inflows and bay circulation, shoreline management, assessments of point- and non-point source pollution, water quality, and public health.

The website also includes links to information on public participation and education, resources for local governments near the Bay, and mapping programs. Two search engines can be utilized. The "Bay Bib" allows users to search through more than 6,000 references related to Galveston Bay. The Galveston Bay Plan Implementation Project search lets users find details on projects funded by GBEP.