New Waves
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Jones Named New TWRI Director; Jordan to Lead MEPS

The Texas Water Resources Institute (TWRI) marked the end of one era and the beginning of a new one in September when a new Director was named. Wayne R. Jordan, who led TWRI since 1984, has been given a new challenge to work within the Texas A&M University (TAMU) Agricultural Program, in which he will lead the Molecular and Environmental Plant Sciences (MEPS) program. His work will involve strengthening the multidisciplinary efforts of Agricultural Program scientists in how crops respond to such environmental stresses as drought and extreme heat.

The new Director is Charles Allan Jones, who has served as an Assistant Vice Chancellor for Agriculture in the TAMU Agriculture Program since 1996. From 1988 through 1996, Jones was the Director of the Texas Agricultural Experiment Station Blackland Research Center in Temple.

Throughout his tenure with TWRI, Jordan worked to establish relationships between the Institute and many partners, including state and federal agencies. He is particularly proud of TWRI efforts to assist the Texas Water Development Board in developing a set of strategic water resources research needs, and work to get the academic community throughout the state more involved in the research programs of the Texas Natural Resource Conservation Commission and other agencies. "I think we made significant strides in bringing the expertise of university researchers to bear on important issues facing federal, state, and local agencies," Jordan says. "It is critically important to involve higher education in investigating and solving water resources problems."

Jordan also sought to make the Institute more than just a TAMU program. Instead, he sought to involve scientists from universities throughout Texas in research projects. He also led the change of the research focus of the Institute. Previously, much of the work centered primarily on irrigation and agricultural issues, but Jordan broadened the emphasis to also include pollution in rural and urban areas, water planning and water rights, the economics of water use, and ecological issues. Finally, Jordan encouraged TWRI to communicate to the public through the use of the WWW and other methods. Under his direction, TWRI developed a major world wide web site and launched e-mail list servers. At the same time, major public education campaigns were initiated relating to water conservation.

Texas A&M Engineers Model Fecal Coliform Bacteria, Dissolved Oxygen, in San Antonio Streams

A team of Texas A&M University (TAMU) agricultural engineers are now doing some major detective work. They are using a suite of complicated computer modeling tools to solve the complicated mystery of how microbial pollutants behave in rivers and streams of the greater San Antonio- region.

Researchers Marty Matlock and Saqib Mukhtar and graduate students Tejal Gholkar and Sabu Paul lead the project. Gholkar has been focusing on how to simulate dissolved oxygen levels, while Paul has been studying the persistence of fecal coliform. The work is funded by the Texas Water Resources Institute (TWRI).

The research centers on better understanding two water quality traits—fecal coliform bacteria and dissolved oxygen—in Leon and Salado creeks in Bexar County. Because these streams have been designated by the state as impaired water bodies, total maximum daily pollutant loads are being considered for them.

According to Matlock, the goal of this study is to better understand whether modeling tools now being used across the United States accurately depict stream processes. Answering that question is likely to be extremely important, since many Texas watersheds are now being modeled as part of efforts to develop water quality management plans. 'The purpose of this work is mostly heuristic - we want to learn more about the behavior of these systems and the models used to predict them.

We anticipate that it will help us solve important pollutant issues," he said. "Specifically, we want to find out whether the simulation models now recommended by state and federal agencies adequately reflect environmental processes in areas with subtropical climates. We need to know if current models adequately simulate processes in the extremely warm waters in man South Texas watersheds which may be ideal for the persistence of fecal coliform indicator bacteria.

The process of modeling water quality is extremely time-consuming and difficult (Matlock says. The first step of this effort was to identify and compile hydrologic data. Then, this information was input to the BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) modeling framework developed by the United States Environmental Protection Agency (EPA). Another major step was to delineate the subwatersheds that feed into these creeks using digital elevation data to create a high-resolution geographic information system (GIS) of the area. The GIS can be used to show how pollutants are affected by various land uses in the region. The hydrologic data were calibrated to

determine how well the data produced by these models matched observed results in the field. Eventually, water quality will be simulated using Hydrologic Simulation Program for FORTRAN (HSPF), which is a watershed and stream water quality model in BASINS.

When this project is completed, Matlock and Mukhtar anticipate it may yield useful insights for other engineers and modelers throughout the region. "We hope that this study will provide an assessment of how well various water quality models work in simulating dissolved oxygen and fecal coliformbacteria, and that we can improve the understanding of these complex processes," Matlock said.

For details, contact Matlock at mmatlock@cora.tamu.edu or (979) 862-7476, or Mukhtar at (979) 458-1019 or mukhtar@ tamu.edu.

Identifying Problems and Solutions Facing the Commercial Fisheries Industry of Texas

Researchers: Quenton R. Dokken, Heidi B. Lovett, and Bonnie J. Ponwith, Center for Coastal Studies, Texas A&M University-Corpus Christi, Corpus Christi, TX, and Teofilo Ozuna, Jr., Erik Ozuna, and Luis Centeno, Agricultural Economics Department, University of Texas- Pan American, Edinburg, TX

Problem: Throughout the 20th Century, the commercial fishing industry developed into a substantial economic enterprise. By 1989, roughly 30,036 people were employed in seafood-related enterprises. The payroll earned by these workers was estimated at roughly $326 million. The stability of this industry, and its economic contributions, may be in jeopardy. The problem is that ongoing declines in fishery stocks in coastal waters and the Gulf of Mexico may trigger a series of events that may weaken the industry. Comprehensive studies are needed to both identify the potential extent of challenges facing commercial fisheries as well as to identify strategies and policies which may benefit the industry.

Goal: To identify and assess potential mechanisms that may stabilize or improve the economic health of Texas commercial fishing industries, and to estimate the contributions of the commercial fishing industry to the economic welfare of Texas coastal regions, given the current status of fish stocks.

Methods: This study was funded by the United States Department of Commerce Economic Development Administration. Workshops were held with stakeholders in April and May 1997 in Port Isabel, Aransas Pass, Port Lavaca, Palacios, Galveston, and Port Arthur. At least six workshops were held at each site to ensure that a demographically diverse audience representing differences in fisheries, businesses, and the types of vessels and boats used. Participation was low, averaging only 10 participants per workshop. During the workshops, participants discussed problems facing the commercial fisheries

industry. A 50-question survey of the general public was conducted about the buying behavior and attitudes of Texas consumers when hen they order or purchased seafood, as well as general attitudes of the public about the commercial fishing industry. Researchers divided Texas into three geographical units (areas within 75 miles of the coast, sites along with the Interstate Highway 35 corridor from Dallas to Laredo, and West Texas). A total of 562 people were surveyed. The effect of federal and state policies on regional economic growth was assessed The researchers investigated trends related to seafood consumption, including wholesale, retail, and over-the-counter sales, restaurant sales, and revenues from value-added products. Data were also gathered on seafood inspections and consumer education.

Results and Discussion:. Meetings with these groups suggest that they are most concerned with economic challenges faced by the commercial fisheries industry, including business operations, national and international markets and competition, image and marketing, community issues, and resource management. Some of the most significant challenges to the future of the commercial fishing industry are the lack of a unifying and guiding organization, as well as a support infrastructure. If such an organization was formed, it could react to address government-imposed management guidelines and restrictions. The researchers found that the commercial fisheries industry is fragmented, since many fishermen have a sense of independence, lack financial resources, and compete against one another for resources. The researchers suggest an active, continuous public education program regarding the industry and its resources be developed. The survey found that the majority of Texans agree that commercial fishing plays an important role in the Texas economy and is a key part of the state's culture that needs to be preserved. The researchers found that people ranked eating seafood third among the top 10 activities they prefer when visiting the Texas coast. They suggest the commercial fishing industry may want to develop tourism-related enterprises such as seafood festivals, opportunities for the public to buy seafood fresh off the boat, and maritime museums. The researchers suggest a Texas Seafood Promotion Board be developed to assist in marketing efforts. They recommend fishermen be proactive in habitat conservation and resource management. They also suggest that the amount of seafood processing now occurring in Texas coastal counties should increase.

Reference: Dokken,Q.R., H.B.Lovett,T.Ozuna,Jr.,B.I.PonYvith, E. Ozuna, and L. Centeno. Texas Fisheries Economic Development Report The A&M-Corpus Christi Center for Coastal Studies, published this report in March 1998.

Note: For details, contact Dokken at (361) 825-5814 or Dokken@falcon.tamucc.edu.

Surveying Water Quality Near a Corpus Christi Canal

Researchers: Brien Nicolau, Terri Wood, and John W. (Wes) funnel!, Jr., Center for Coastal Studies, Texas A & M University Corpus Christi (A&M-Corpus Christi), Corpus Christi, TX.

Problem: The Tropic Isles Homeowners' Association (TIHA) was having problems with seagrasses being blown into a nearby canal by southeast winds. The seagrasses would then be blown throughout the canal system and,, since there is no outlet, pile up and decay The decaying seagrass smell bad and lower the amount of dissolved oxygen (DO) in coastal waters, especially during warm parts of the year. Marine animals need significant levels of dissolved oxygen for their survival. TlHA contracted with the Center for Coastal Studies (CCS) at A&M Udniversity-Corpus Christi to study how this problem could be resolved.

Objectives: To assess the health of the Tropic [Isles Canal SVS_ tem ecosystem using such factors as the richness, abundance, and diversity of the benthic macroinfauna in the area. Also, to collect surface water quality data relevant to standards developed by the Texas Natural Resource Conservation Commission (TNRCC) for this water body.

Methods: The biological community was assessed by collecting representative samples at 17 locations in April 1998. Samples were taken with a standard post-hole digger, which retrieved a core. Samples were bagged, preserved, and sent to CCS where organisms were sorted, counted, and identified to the lowest taxa. The Shannon Diversity Index was used to calcula te species diversity. To asses water quality, standard TNRCC field measurements of water temperature, dissolved oxygen, pH, conductivity, and salinity were tested for each sample. Water quality samples were collected from the surface and the bottom at each site in April and August 1998.. A Hydrolab Surveyor III multi-probe was used to take samples once every 6 hours throughout a 94-hour period. A marked staff was used to determine the water depth when samples were taken at each site. Water chemistry samples were collected and sent to Jordan Laboratories in Corpus Christi, and were analyzed for ammonia nitrogen, nitrate and nitrate-nitrogen, and total phosphorus.

Results and Discussion: Analysis of the biological core samples showed that the Tropic Isles Cana l System (TICS) is stunted regarding aquatic benthic biota, when compared to a reference site in the Laguna Madre. Species diversity in TICS was low and five locations that produced no living organisms. The water quality assessment reported relatively good conditions for this area. Temperature and pH levels were relatively normal during the first monitoring period, but were slightly elevated when the second set of samples were taken. Salinity levels were lower than normal for this area. Levels of dissolved oxygen (DO) during the April sampling event were relatively healthy, but there was evidence of a stratified water column. During the August sampling event, the DO levels were found to be severely depressed throughout TICS. Warm temperatures and high salinity levels may produce low DO concentrations, but poor hydrologic flows and large amounts of floating and decaying debris in the TICS will likely continue to decrease DO levels. Water

chemistry analyses found that the ammonia concentrations and phosphorus levels were relatively high and the ammonia concentrations exceeded TNRCC screening levels. Excessive ammonia can alter the metabolism and impair the morphological development of fish. Phosphorus levels for the April sampling event were high, likely due to rainfall runoff. The phosphorus loadings may have originated from agricultural or urban runoff or from wastewater treatment. Phosphorus levels decreased in August. Part of the problem stems from the way in which the TICS was built, since its design restricts the flow of water. Approximately 95 to 100% of man-made canals like TICS may have similar problems, because they are closed and do not enhance the circulation. This canal system is often affected by pollution from non-point sources such as litter, fertilizer, and grass clippings. A solution may be to install a gate to trap seagrasses before they can flow into the canal, but preliminary tests of this method have not been promising.

Reference: Nicolau, Brien A., Terri M. Wood, and John W. Tunnell, Jr, Tropic Isles Homeowners, Association Water Quality Survey Laguna Madre, Texas, Center for Coastal Studies, Texas A & M University-Corpus Christi, Corpus Christi, TX.

Note: Tunnell can be contacted at jtunnell@falcon.tamucc.edu or at (361) 825-2786. The Center for Coastal Studies is on the World Wide Web at http://www.sci.tamucc.edu/ccs/.

Use of a Pilot Study of the Perdernales River to Assess Water Quality in the Lower Colorado River Basin

Researcher: Michael E. Barrett, Center for Research in Water Resources (CRWR), University of Texas at Austin, Austin, TX.

Problem: The Lower Colorado River Authority (LCRA) wanted to determine the best way to evaluate the potential problems that may be encountered, and the time required to complete, a study of the entire lower Colorado River system. The Pedernales River was chosen for a pilot study because it incorporates many of the same elements of the Colorado River.

Objective: To assess the parameters that need to be included in a study of the entire river system, and to determine if a pilot study can be used to develop a modeling framework to evaluate the water quality of the Lower Colorado River watershed. Also, to ascertain if water quality data collected from the Pedernales River exhibit temporal and spatial trends which can be used to infer the sources of water quality impairments affecting the river system.

Methods: From 1984-1997 the LCRA and the Texas Natural Resource Conservation Commission (TNRCC) wanted to find the concentrations of 24 constituents to determine current water quality in the Pedernales River, and whether there are any significant water quality trends are present. Starting in 1984, the TNRCC placed four monitoring stations along the Pedernales River stretching from Johnson City to upstream of the river's

confluence with Falls Creek. From 1984 through 1997, 7,200 measurements of these constituents were made at the monitoring sites. A subset of constituents was selected for more detailed statistical analysis including dissolved oxygen (DO), specific conductance, sulfate, chloride, ammonia, nitrate plus nitrite, total Kjeldahl nitrogen, total organic carbon, total phosphorous, and fecal coliform The average daily flow of the Pedernales River was "aged by the U. S Geological Survey at Johnson City. An analysis of variance (ANOVA) was used to conclude whether there were spatial trends in the water quality data.

Results and Discussion: Monitoring data found the water qualitv of the Pedernales River was very good and supportive of all designated uses. All of the constituents that varied had higher concentrations upstream than downstream. including DC), chloride, sulfate, nitrate plus nitrite, and specific conductance. Groundwater may carry higher levels of these constituents because of fertilizers and pesticides from agricultural activities. Barrett suspects that groundwater flows into the river may contribute to pollutant levels in the river. Currently, concentrations of all monitored water quality constituents are generally below any levels of concern Most water quality parameters are remaining relatively constant or improving There is no immediate concern that changes in land use or human activities threaten water quality, but the source of low concentrations of DO and high levels of nutrients should be analyzed. There have been eight fish kills along the Pedernales River, five of which have occurred since 1990 Roughly half of the kills are thought to have been caused by illegal dumping of toxic substances into the river. It is recommended that an effective public education and outreach program be started in order to prevent such events. The remaining fish kills are thought to be the result of wastewater treatment plant discharges into the Pedernales River near Johnson City, resulting in low DO levels. Barrett suggests that a review of the permit requirements and adequacy of the Johnson City Wastewater Treatment Plant may be needed

Reference: Barrett, M. E, Analysis of Pedernales River Water Quality (CRWR Online Report 98-6), CRWR, Austin, TX, 1998

Notes: This report can be downloaded from the CRWR World Wide Web site at http://www crwr.utexas.edu/online.html Barrett can be contacted at mbarrett@mail.utexas.edu or (512) 471-0935

Evaluating the Success of a 1997 Program to Suspend Irrigation in the Edwards Aquifer Region During Dry Years

Researchers: Keith Keplinger, Texas Institute for Applied Environmental Research (TIAER), Tarleton State University, Stephenville, TX, and Bruce McCarl, Agricultural Economics Department, Texas A & .M University, College Station, TX.

Problem: During 1996 the Edwards Aquifer region, along with most of Texas, experienced a severe drought. During this drought, there were serious concerns that flows of water into Comal and San Marcos Springs would diminish to such low levels that conditions for endangered species would worsen. In the Edwards Aquifer region, the level of springflow is determined by the amount of water recharged to the aquifer as well as pumping. Throughout the 1996 drought, many plans were enacted to lessen water use, but they did not result in higher springflows. Currently, roughly 80,000 acres of cropland, located mainly in the western part of the watershed, are irrigated with groundwater from the Edwards Aquifer Between 1982 and 1996, annual irrigation water use averaged 127,000 acrefeet (AF), although higher volumes were pumped in dry years. To lessen water use and boost springflows, the Edwards Aquifer Authority (EAA) initiated a pilot irrigation suspension pro~gram (ISR) in January 1997. The success of that program, in terms o water savings, springflows, and costs and benefits, needs to be evaluated.

Objectives: To examine the impact of the 1997 ISP on groundwater use from the Edwards Aquifer and flows to Comal and San Marcos springs, and to assess the economic efficiency of the ISP.

Background Information 1 The goal of the ISR was to encourage agricultural producers to submit bids to EAA, indicating the amount of financial compensation they would need to not irrigate during the upcoming growing season. It was hoped that farmers would enroll 1O,OOO acres in 1997. Eligible irrigators were selected by the EAA based on the location of individual wells, and an assessment of the extent to which these wells may influence flows at Comal Springs. Other considerations included irrigation use from 1995 and 1996, and the type of irrigation equipment used by each farmer. Participants had to commit to use dryland farming methods (no irrigation) on the acres to be enrolled. irrigators who met these requirements were eligible to submit bids to EAA. E.N.N estimated the potential impact of the ISP on crop mixes, irrigation pumping, aquifer elevations, springflows and irrigation return flows. ENA also projected the direct and indirect effects of this program on local economic activity.

Results and Discussions: The program received 125 bids, of which 120 met the lS Prequirements. Bidsrange.tfrom$11('to$750peracre, with the median being roughly $300 per acre. The cost of enrolling 10,000 acres in the program totaled $2.26 million or an average of $234 per acre. Money to pay the irrigators was contributed through pledges from water utilities and other large aquifer pumpers throughout the region. These donations totaled 52.35 million. Results suggest that the ISP may have played a role in influencing crop mixes in the area, increasing sorghum and wheat acreage while lessening the number of acres of peanuts, vegetables, and cotton. Participating irrigators

were asked whether enrolling in this program actually reduced their water use. Based on an analysis, which included data from the U.S. Geological Survey and the Texas Water Development Board (TWDB), it was estimated that the ISP reduced pumping by over 23,000 acre-feet (AF), when compared to estimated water use in a typical dry year. Actual field data suggest that many irrigators used 0.4 AF in 1997, in part because of substantial rains. As a result, reductions in agricultural groundwater use were estimated at only 3,868 AF. The effect of the ISP on springflows was estimated. Results suggest that roughly 40% of the volume of springflows may be correlated to agricultural groundwater use. Consequently, the ISP was estimated to boost springflows by 2.9 cubic feet per second.

Other key findings are that the ISP may increase aquifer levels by 3.8 feet in dry years, and by 2.5 feet in average years, and that return flows from irrigated fields were lessened by 7,948 AF by this program. Keplinger and McCarl suggest that implementing the ISP in the spring or fall (not in January, as was done in this case) may increase participation and lower the cost of bids submitted by irrigators. Keplinger says the ISP seems to have the potential to increase spring flows and aquifer elevations, especially during dry years.

Reference: Keplinger, Keith O., and Bruce A. McCarl, "An Evaluation of the 1997 Edwards Aquifer Irrigation Suspension," Journal of American Water Resources Association, Vol. 36, No.4 (2000), 889-901.

Note: For details, contact Keplinger at (754)-968-9572 or at keplinger@tiaer.tarleton.edu, or McCarl at (979)-845-7504 or at mccarl@tamu.edu. TWRI published a technical report, *The 1997 Irrigation Suspension Program for the Edwards Aquifer: Evaluation and Alternatives* (TR-178) which discusses issues related to this program.

An Analysis of How Senate Bill 1 Altered Issues Related to Water Law and Water Planning in Texas

Researcher: Frank Skillern, School of Law, Texas Tech University, Lubbock, TX.

Problem: In 1996, following the latest of a series of severe droughts, Texas legislators and policy makers crafted Senate Bill 1 (SB 1). Viewed by many as landmark legislation, SB1 significantly altered many key aspects of water management in Texas, especially as it relates to water planning and conservation. In order to fully comprehend the magnitude of change brought about by SB 1, a historical and legal perspective of Texas water law is required.

Policy before SB 1: The Water Planning Act of 1957 gave the Texas Water Development Board (TWDB) the responsibility of long-term water resources planning. Historically, the role of TWDB was to develop a statewide water plan that focuses on predicting water shortages, developing new water supplies, and reducing demand by

conservation, recycling, and reuse. A significant problem with this process is that water plans developed by TWDB are not regulatory unless acted into law. The Texas Natural Resource Conservation Commission (TNRCC) has had the authority to require applicants for water rights to prepare a conservation plan for new or amended water rights, but has not required these plans be submitted or approved. The sale or lease of water rights is another area which has been the source of confusion in Texas water law. As a result, activity in water marketing has been slow. In 1931, the Wagstaff Act was enacted to ensure domestic and municipal water supplies received the highest priority for water use, especially in times of drought. Until 1997, Texas water law remained unclear regarding the rights of cities during droughts or other water-related emergencies. Finally, Texas is one of the last states, which still use the rule of capture for groundwater resources. Since 1994, many groundwater conservation districts have had the power of permitting, well-spacing, and setting the amount of withdrawals. Many districts have deferred to the rule of capture and have recognized a landowner's right to pump by not imposing mandatory regulations on the amount of water withdrawn. In many districts, the regulatory authority of these agencies does not cover overlying aquifers and, therefore, the rule of capture is in effect.

Changes after Senate Bill 1: Senate Bill 1 requires the TWDB to prepare a state water plan to guide water policy. The TWDB is required to have its first plan by 2001 and update it every five years. SB 1 directed the TWDB to incorporate the views of regional planning groups as an integral part of the planning process. Typically, regional planning groups are comprised of state and local of officials, major water users, municipalities, industries, and environmentalists. A key feature is that each group was assigned to plan for the needs of its region throughout the next 50 years. SB 1 expanded the role of TWDB in water marketing by strengthening the Texas Water Bank. TWDB was directed to serve as a clearinghouse for water transactions, providing information to potential buyers and sellers about pricing, water availability, and environmental considerations. SB 1 also gave the TNRCC the power to allow the use of natural streams to move return flows from privately-owned groundwater or appropriated waters to downstream sites. Persons wanting to transfer water rights from one river basin to another must apply to the TNRCC for a permit, and public hearings must be held in each basin before any transfers can be approved. If transfers are contested, the TNRCC must hold an evidentiary hearing. The bill requires that applicants for new or amended permits must submit a water conservation plan and adopt reasonable water conservation methods in order to change an appropriation or point of diversion of the water. SB 1 also repealed the Wagstaff Act, and gave the TNRCC broader authority to grant applications for emergency authorizations to transfer water from other sources for municipal supplies.

Analysis and Discussion: The importance of SB 1 is that it declares a clear state water policy to ensure municipal supplies at a reasonable cost, advocates conservation of available waters, and encourages voluntary water transfers through marketing. The bill also represents a change of course from previous efforts in that it treats the development of new supplies through reservoir building as a low-priority alternative to conservation and marketing. The bill provides better protection of the environment by strengthening requirements for instream flows, water quality, and flows to coastal bays and estuaries.

Reference: Skillern, F., "Managing Water Resources in Texas: Water Policy for the Future," *Rivers*, Vol. 6, No. 3, 1998: 194-203.

Note: For more information, contact Skillern at ffs@ttacs.ttu.edu or at (806) 742-3789.

GLO Awards Grants for Water Resources Research Dealing With Hypoxia, Shoreline Changes, Education

The Texas General Land Office (GLO) recently awarded grants for five research projects to university scientists.

The projects include the following

- "A Geographic Information System (GIS) Database of Hypoxia, Low-Oxygen, Conditions in Corpus Christi Bay" will be developed by Paul Montagna of the Marine Sciences Institute at Port Aransas, which is part of the University of Texas at Austin (UT). The goal is to create information which can be used to help manage coastal areas to prevent hypoxia. The project will identify and develop strategies for coping with the effects of low oxygen conditions. Data will be gathered with oxygen recorders at 20 sites during severe hypoxic events. The GIS will summarize hypoxia data collected since 1994.
- "Sand Resources and Movement off Galveston Island Beaches" will be studied by William Seitz and Tim Dellapenna of the Marine Sciences Department at Texas A&M University-Galveston. The bottom profile will be obtained from Galveston Island beaches to 40 feet offshore. Two high-resolution digital systems will be used to scan seabeds and observe morphological changes in the geometry of beaches and bars along the inner shelf. Surveys will be conducted near beach sites which have been nourished by the City of Galveston and near Pirates' Beach.
- "Down to Earth at Mustang Island" is the title of a project by Jay A. Raney of the Bureau of Economic Geology (BEG) at UT. This project will produce an attractive illustrated guide on the geology and natural history of Mustang Island. The guide will include information on natural processes, and interactions of flora and fauna with the physical environment of the island. The user friendly guide will be made available to educators and students in public schools.
- "The Coastal Hazards Atlas of Texas Volume 4: A Tool for Hurricane Preparedness and Coastal Management," will be developed by James Gibeaut of the UT BEG. This effort will develop a coastal hazards atlas for the region stretching from Baffin Bay to the Rio Grande. It expands on previous work to develop an atlas for the Middle and Upper Texas coasts.
- "Shoreline Changes in West and Christmas Bays" will be investigated by James Gibeaut of UT BEG. This project will determine the rate of shoreline change in these parts of the Galveston Bay system which have occurred since 1982.

TTU Scientists Test Use of Constructed Wetlands to Treat, Reuse Animal Wastes

When most people think of what can be done with waste from cattle feedlots, they think of compost or fertilizer. But is it possible that feedlot waste can be turned into something more useful? To a group of scientists at Texas Tech University (TTU), the answer is yes.

Cattle feedlots and other animal production operations p produce a large amount of waste, but what to do with these wastes is a good question. According to Clifford Fedler of the TTU Civil Engineering Department, a typical feedlot steer annually excretes 8.8 tons of waste (dry weight) per 1,000 pounds of live weight. In Texas that means approximately 20 million tons of waste must be properly handled and processed in an environmentally sound manner.

Recently, Fedler, researcher Nick Parker of the Texas Tech Cooperative Fish and Wildlife Research Unit, and graduate students Troy White and Prasuo Sahu of the Civil Engineering Department have worked to create products for agriculture and aquaculture from waste. The idea is to take waste from feedlots, send it through a constructed wetlands for treatment, grow plants for feed, and reuse water from these operations for irrigation or in fish ponds.

Waste, wastewater, and manure, are collected at the TTU Animal Science Facility from 1,000 head of cattle and 180 sows. Waste from the feedlots is collected and placed into integrated facultative ponds. These ponds contain a small pool within a larger pond. In the integrated facultative pond, anaerobic matter grows and breaks down the waste into methane, carbon dioxide, and water. Knotgrass (*Paspalum disticlum*) a plant which is similar to alfalfa and is hardy and rich in protein, is grown in the wetlands. It can be harvested and used as a feed for cattle and sheep. The wetlands are periodically dried to grow more knotgrass and to allow for plant harvesting. Water from the wetlands can be used for irrigation or for fish production. "The reason we used knotgrass is because it grows so well. It can go dry for a long time and become dormant, yet it can also stay flooded for long periods and still continue to grow, which is necessary with wetlands used for waste treatment," said Fedler.

Fedler has tested the system for three years. After testing a variety of wet and dry cycles during a 42-day period, the best sequence seems to be a rotation of seven wet days and two dry days. "We were quite surprised with some of our results. We were expecting higher nitrogen removal by the plants. Plant growth was far greater on the upper or entrance end of the wetland cell than the bottom or the effluent end of the cell," said Fedler.

In the future, water which has flowed through such a wetlands system may be used for aquaculture production of such tropical fish as swordtails, koi, mollies, and tilapia, as well as such sportfish as bass, carp, and catfish. Fedler believes the wetland system can be implemented in feedlots across the nation immediately.

This project was funded by a variety of sources, including the Texas Higher Education Coordinating Board, the U.S. Environmental Protection Agency, the Texas State Soil and Water Conservation Board, and the U.S. Department of Energy. For details, contact Fedler at clifford.fedler@coe.ttu.edu or at (806) 742-2801, or visit a World Wide Web site about this project at http://www.ce.ttu.edu/faculty/fedler/Research.htm.

TAMU, TTU, OU Create "SMART-R" Weather Radar System

Scientists and engineers at Texas A&M University (TAMU), the University of Oklahoma (OU), Texas Tech University (TTU), and the National Severe Storms Laboratory (NSSL) have teamed up to create the Shared Mobile Atmospheric Research and Teaching Radar (SMART-R) system. Researcher Mike Biggerstaff of the Atmospheric Sciences Department leads TAMU efforts in this project.

SMART-R will utilize C-band mobile Doppler radar, instead of X-band radar which is now widely used. C-band radar has longer wavelengths which allows scientists to see weather over greater distances in heavy rain as well as the front and back of storms. C-band radar will improve physical understanding of convective storms that produce tornadoes and hail, may help to improve current cloud modeling mechanisms, and may better weather forecasting. "The radar will provide rainfall projections that we can compare to satellite estimates so we can improve weather estimates," Biggerstaff said.

SMART-R will be used for a variety of weather-related projects, including rainfall prediction and forecasting, studying supercells, and detecting hail. At TAMU, SMART-R will be used to gather meteorological data and as an educational tool for undergraduate education. "Texas A&M students will receive education and training in radar meteorology and storm forecasting that extends beyond anything that can be conducted in a classroom," Biggerstaff says. "They will actually be operating the equipment and deciding in real-

time how to sample a storm system. This will put their knowledge to the test regarding storm forecasting," Biggerstaff said.

Currently, TAMU is working to build this system. Custom interfaces needed to attach motors, power amplifiers, and the radar dish onto the pedestal are being created. Hopefully, the SMART-Rs will be ready for deployment in April 2001. When operational, this mobile system will an 8-foot antenna on a 33-foot-long truck that can be taken to remote sites throughout the region. The system is jointly owned by TAMU, TTU, OU, and the NSSL. Each institution provides resources for the project. TAMU is responsible for building the radar system, while NSSL and OU are providing the truck platforms. TTU is supplying signal processors needed for Doppler translation.

Funding for this project is provided by the NSSL and participating universities. For details, contact Biggerstaff at mikeb@ariel.met.tamu.edu or at 979-845-7671.

On-Line Technical Reports Available from UT CRWR

A number of recent technical reports focusing on water resources research are available from the Center for Research in Water Resources (CRWR) at the University of Texas at Austin (UT). Since 1995, CRWR has published the full text of more than 30 "on-line" reports that can be downloaded from the Center's World Wide Web (WWW) site.

The reports cover a multitude of topics, including floodplain mapping, risk assessment, water rights, the use of geographic information systems, industrial sewers, and many others. The reports can be viewed and saved using the free Adobe Acrobat reader software.

In addition, CRWR has also published many technical reports that are available in print format but are not on the WWW. Generally, these were published before 1995.

To access any of these reports or for more information, visit the CRWR WWW site at http://wvvw.ce.utexas.edu/crwr. The phone number is (512) 471-3131.

Books Describe Pollutant Research at Rice University

A series of 10 books describing research in pollution cleanup has been published by CRC Press. These monographs explain investigations undertaken through the Advanced Applied Technology Demonstration Facility (AATDF). C. Herb Ward, the Director of the Rice University Energy & Environmental Systems Institute, administered this program. The reports cover such issues as the use of surfactants and sequenced review barriers for bioremediation, use of a modular testing system for quantitative demonstration of emerging technologies, phytoremediation of soils contaminated with hydrocarbons,

thermally enhanced soil vapor extraction, and the use of laser-induced fluorescence to monitor contamination.

More information about individual reports can be obtained by visiting the CRC World Wide Web site at http://www.crcpress.com. Orders can be placed by contacting CRC Press at 800-272-7737 at orders@crcpress.com. For more details on the AATDF program, contact Ward at wardch@rice.edu.

Nebraska Press Publishes Book on Ogallala Aquifer

The University of Nebraska Press (UNP) recently published the second edition of a book, Ogallala–Water for a Dry Land. The book was written by John Opie, a historian with the New Jersey Institute of Technology. The book provides an environmental history of the Ogallala aquifer and farming in the Great Plains region. It also addresses the impact of the 1996 Farm Bill (Federal Agricultural Improvement and Reform Act) on agriculture and water use, and examines the recent movement of industrial hog farming into the region. Sections of the book cover such issues as early exploration ' of water in the region, the impact of the dust bowl on groundwater x/ supplies and farming activity, and the impact of center pivot irrigation on the region. Case studies of five water districts are presented. For details, visit the UNP World Wide Web site at http://www.nebraskapress.unl.edu.

Texas Western Press Updates El Paso's Geologic Past

A new edition of a book which describes the geology of the El Paso area has recently been published by the Texas Western Press at the University of Texas at El Paso. The book, El Paso's Geologic Past, was originally written by former UTEP Geology Department professor Earl Lovejoy.. This new version was updated by William Cornell, who is a scientist with the UTEP Geology Department.

The book describes the Rio Grande Rift which is a major geologic feature in the area, and includes new photographs, a self-guided tour, and an updated bibliography. To order, contact the Texas Western Press at (800) 488-3789.

New Research Facility Allows UNT Scientists to Study Effects of Pollutants on Stream Ecosystems

Biologists at the University of North Texas (UNT) and the city of Denton have recently developed a research facility that will facilitate the study of how pollutants maybe affecting water quality in lakes, rivers, aquatic habitats, and wetlands in the region.

The UNT Experimental Stream Facility opened in May. The center is located at the City of Denton Pecan Creek Wastewater Management Plant. Tom LaPoint, the Director of the UNT Institute for Applied Sciences, heads a team of scientists who conduct studies at the site.

The research center consists of 12 man-made "streams" that imitate natural rivers found throughout the region. Each experimental stream is 16 feet long and two feet wide. To mimic real world conditions, the streams were built with a gravel substrate, and pools were placed at the end of each stream segment. Water is supplied by the wastewater plant. A variety of aquatic organisms (including insects, larvae, snails, invertebrates, and fish) was obtained from Pecan Creek for use in this system. Wastewaters that flow through the facility will be rout routed back to the treatment plant to prevent possible contamination.

Throughout the summer of 2000, LaPoint and colleagues have been using this site to study how pollutants affect aquatic life in the surface waters. Minnows, bluegill sunfish, and other fish have been added to the downstream pools, where they have been exposed to contaminants throughout a 30- to 60-day period. Changes in the growth, behavior, and mortality of fish at the research site are being compared to laboratory studies in which fish are exposed to individual contaminants.

"The chemicals being tested in this initial study are surfactants and cadmium. Surfactants are common downstream from wastewater treatment facilities and cadminum is a common heavy metal in stormwater runoff," LaPoint said.

In the future, LaPoint anticipates that this facility may be useful in investigating the role of invertebrates in bioaccumulating pollutants bound in sediments, the role of nutrients in pollutant transport in streams, and many related topics. The site may also be useful in coping with emerging pollutants of concern like MTBE and atrazine, and may also be useful in assessing the performance of various designs of wastewater treatment plants.

"We hope this research will help us better understand the interactions among different contaminants in freshwater streams, particularly as they affect fish and invertebrates,"

LaPoint says. "When this study is complete, we hope it will help us assess risks associated with wastewater effluents in many streams throughout Texas and arid regions of the western United States."

TWRI Project Seeks to Find Ways to Use Waters Generated by Oil and Gas Production

A diverse team of researchers from Texas A&M University (TAMU) recently began taking initial steps to disprove the old adage that oil and water do not mix. In this case, the scientists met to lay the groundwork for a program which may take some of the tremendous amounts of water created in oil and gas production and put it to use to restore rangelands and ecosystems. The scientists were brought together by a faculty incubator grant provided by the Texas Water Resources Institute (TWRI). The idea of this program is to create teams of interdisciplinary researchers to address critical water resources and environmental issues. The grants provide start-up funds for teams of scientists to get together, develop proposals for comprehensive research projects, conduct literature searches, and meet with funding agencies to discuss ideas. Ideally, tire the hope is that the faculty incubator grants can be used as leverage to obtain significant research funds.

At the initial meeting of this group in September, a diverse mix of TAMU scientists and engineers participated. The group included project leader David Burnett, Duane McVay, and Maria Barrufet from the Petroleum Engineering Department, Bill Batchelor of the Civil Engineering Department, Doug Loh of the Rangeland Ecology and Management Department, John Bickham of the Wildlife and Fisheries Sciences Department, Tim Phillips of the College of Veterinary Medicine, and Farzeneh Jebrail of the Texas Engineering Extension Service. Others taking part included Ric Jensen of TWRI and Linda Cleboski of the International Agriculture Programs Office. Professionals and staff from West Texas A&M University-and the Texas Agricultural Extension Service have also expressed interest in joining this team.

According to Burnett, a fundamental problem in mature West Texas oil fields is that roughly seven barrels of water are produced for each barrel of oil which comes out of the ground. In West Texas, more than 400 million gallons of water are produced daily. Once the oil has been recovered, something has to be done with this produced water or brine. To-date, the management strategy has been to dispose of produced water in underground injection wells. However, Burnett suggests this is a waste of water and is costly to oil and gas producers.

"We want to find out if we can lessen the cost of disposing of oilfield brine and help oil and gas producers operate more efficiently," Burnett said. "We also want to learn how we can take this significant volume of water and use it to improve the environment, especially in parts of West Texas where water is scarce. That means we will have to learn about the chemistry of pollutants in produced waters, the water quality we need to put brines to beneficial uses, and how we can treat these wastes so they can be suitable for irrigation and revitalizing ecosystems."

The group has already selected a site which will provide needed data on water quality characteristics of brine, and that may serve as the location of future research and demonstration projects. Burnett has already worked with the Marathon Oil Company's Yates Well Field near Fort Stockton, which was one of the first major oil reserves developed in Texas. Roughly 75,000 barrels of produced water are generated at the site each day. Burnett hopes that the efforts of this team may be able to find ways to treat and reuse roughly 10% of the brine which is produced. Currently, it costs about $24 to dispose of 100 gallons of produced water. Getting a team with such mixed areas of expertise and points of view yielded insights into a number of areas which need to be explored. McVay noted there might be opportunities to reduce the amount of water that is generated during oil production, thus lessening the amount of brines that are generated. Batchelor suggested the team take a holistic look at the entire process, including the need to dispose of brines near sites at which they are produced, and to match the level of water treatment to the intended use. He said it may not be necessary to treat brines to drinking water standards if they will be used for irrigation of non-food chain agricultural crops as well as the rehabilitation of ecosystems. Jebrail descri capabilities to test water quality parameters at the site using a mobile unit. Phillips noted that many high-tech clay compounds hold the promise for reducing the levels of pollutants in brine so that produced waters would exhibit the quality needed for reuse. Loh noted that brines could be used to irrigate and restore prairies, rangelands, and wetlands. Bickham explained that animals living near the site could be used as sentinels to monitor whether pollutants in treated brine may be adversely affecting the environment.

The next step in the process, Burnett says, is to have the individual scientists and engineers develop specific research proposals, which they may want to pursue as part of this project. For example, Marathon has shown an interest in working with the team to see how brine disposal costs can be lessened. Soon, the team hopes to present this issue and the expertise of individual members to potential sources of funding.

Note: Funding for this faculty incubator team extends through August 31, 2001. Other faculty incubator teams funded by TWRI are examining wastewater treatment, aquaculture, assessments of the condition of small watershed dams, using genetic biomarkers to trace pollutants, and many other issues.

TAMU, USGS Scientists, Study Whether Methane Is Present Beneath Landfills, How it May Naturally Decay

Is methane present beneath landfills and, if so, is it naturally degraded before it leaks into aquifers? These are some of the questions now being studied by scientists at Texas A&M University (TAMU) and the United States Geological Survey (USGS). Lead scientists in this project include Ethan Grossman of the TAMU Geology and Geophysics Department, Luis Cifuentes of the TAMU Oceanography Department, and Isabelle Cozzarelli of the USGS.

The research is being conducted at a landfill in Norman, OK near the Canadian River. The unlined landfill operated from 1922 to 1985 when it was closed. Afterwards, it was capped with clay and revegetated. The landfill may pose a potential pollution problem since waters flowing downward through the site may leach contaminants from decaying organic material present in wastes deposited at the site. Because the landfill is unlined, contaminants may readily infiltrate the underlying shallow aquifer and form a leachate plume. The plume at this landfill is being studied as part of the USGS Toxic Substances Hydrology Program. In this study, the researchers collected water samples from seven wells installed a various depths along a 210-meter flow path of the plume.

The researchers found that waters contaminated by landfill leachate were characterized by high levels of chlorides, alkalinity, total dissolved organic carbon, and methane. Grossman says the methane comes from the anaerobic decay of solid and dissolved organic matter, and represents an explosion hazard as well as a potentially significant contribution to global warming. "Landfills are the largest man-made source of atmospheric methane in the United States," he said. Grossman said a surprising finding is that, in this case, is that stable carbon isotopic ratios (13-C and 12-C) suggest anaerobic bacteria are oxidizing methane. "Landfill methane is typically oxidized in the presence of oxygen by aerobic bacteria," he said. "It is very unusual to find anaerobic methane oxidation in an aquifer setting. The research shows that 80% to 90% of the methane was oxidized within the plume before it reached the Canadian River, thus helping prevent methane from escaping to the atmosphere. Given an average rate of groundwater flow of 15 meters per year, the vast majority of methane will be consumed within 14 years," said Grossman.

A puzzle that has been difficult to solve, Grossman says, is the role that specific anaerobic microorganisms play in methane oxidation and the natural bioremediation of other toxic contaminants in leachate plumes. Grossman says that these questions will be the focus of future studies.

Better Understanding Of How Hydrologic Uncertainty May Affect Water Transfers is Goal of UT Study

When water rights are bought and sold, how do the different parties deal with the economic risk that the water they have acquired may not be there when they need it? For example, how would a drought or flood affect a user's ability to use recently purchased water rights? Developing a better understanding of the hydrologic risks associated with water rights transactions is the emphasis of an ongoing research program headed up by David Eaton of the Lyndon B. Johnson (LBJ) School of Public Affairs at the University of Texas at Austin (UT). The project was funded through the National Institute for Water Research competitive grants program and is administered by the Texas Water Resources Institute.

The project involves a comprehensive team of researchers including Peter Wilcoxen of the UT Economics Department, 17 LBJ School graduate students, Daniel Sheer of Water Resources Management, Inc., and Deborah Knopman of the Progressive Foundation.

The thrust of the project is to try to better assess, or quantify, the risks faced by buyers, sellers, or other affected parties when water rights are leased or sold. Rainfall, runoff, drought and other weather parameters are highly variable and greatly affect how much water may actually be available at a given point and time. Because this stochastic nature of flows is generally not considered when water rights are transferred, it may limit the interest of key publics in participating in the buying, selling, and leasing of water rights.

To study this problem, Eaton and the research team interviewed water resources managers, water users, and environmental professionals from Texas and other Western states. Subjects were asked to describe the interests of buyers, sellers, and third parties. In addition, focus groups and interviews were used to help estimate the values and consequences of water trades. The likelihood that water transfers may not work out as planned, based on variations in weather, was evaluated using hydrologic data and input from experts. The economic impact of those scenarios was also assessed.

Research in this project focused on the Guadalupe-Blanco and Rio Grande river basins. For these watersheds, simulation and optimization river basin models were developed and proposed reallocation strategies were analyzed. The research team also generated estimates of the cost and value of waters transferred under different assumptions.

"A product from this research will be a framework which can be used to determine if a potential trade in water or water rights is in the interest of buyers, sellers, or third parties which may be adversely affected, the environment, or the State of Texas," Eaton says. "There may be many opportunities in which everyone benefits, and this research will help people identify and examine case studies of which projects have merit, as well as ones which should not be approved."

UNT Biologists Develop WWW Site That Displays Data from Clam-Based System Water Quality Monitoring System

A team of researchers and students at the University of North Texas (UNT) has created a World Wide Web (WWW) site page which displays real-time information about a biological-based system to monitor water quality at Lake Lewisville and the Elm Fork Watershed of the Trinity River.

The ECOPLEX project is funded by the U.S. Environmental Protection Agency (EPA), and is a joint effort with the City of Denton. Many UNT researchers are involved in the ECOPLEX project, including William T. 'Tom" Waller, Ken Dickson, Miguel Acevedo, Sam Atkinson and James Kennedy of the Institute for Applied Sciences (IAS).

City of Denton staff members Jim Coulter, Howard Martin, Kevin Thuesen are working closely with UNT in this effort.

The main WWW site for this project is titled "ECOPLEX," and an be located at http://www.ecoplex.unt.edu. ECOPLEX presents a wide assortment of information about current environmental conditions and short-term forecasts for the Dallas-Fort Worth area. Data covers such issues as water quality (biological and chemical parameters), solar radiation (the ultraviolet index), water quantity levels of area reservoirs), land resources (aerial photographs), and weather conditions (satellite and radar images). The information is updated instantly.

Through this WWW site, users can access real-time information about water quality, based on a methodology Waller developed to use an Asiatic freshwater clam (*Corbicula fluminea*) to indicate if surface waters are polluted. Other scientists working with Waller on the clam gape studies include UNT graduate students Joel Allen, Pat Lambert, and Jon Hemming. Researcher Larry Ammann of the University of Texas at Dallas Mathematics Department is playing a key role with data analysis and interpretation.

The basic idea is that the clams will open their shells if water with good quality is present, but will close them if they are exposed to pollutants. In this system, the clams are fitted with a proximity sensor that detects the degree of gape (the extent to which a clam's hell is open or closed). Graphs showing the extent of clam gapes at two gauges are presented on this WWW site.

Currently, Waller has been testing this system at Lake Lewisville and at sites in the Elm Fork Watershed of the Trinity River. Clams have been fitted on racks in these waters. Data are transmitted via cellular modems to a UNT laboratory and are posted on the

ECOPLEX WWW site. Whenever the clams close their valves, an automated sampler is activated and water quality collected for analysis. Later, these samples are tested for toxicity.

"Clams often respond to certain toxic substances and other changes in water quality by closing their shells for a period of time," Waller says. "If the clam shells remain shut for a lengthy time period, the water samples will be tested to see if they are toxic to other aquatic species like water fleas. If this follow up testing suggests there may be a problem, we can take additional steps to find out what type of pollution is present where it may have originated from, and how we can manage and or remove that source of contamination."

The researchers are also monitoring water quality using a probe that gathers data on pH, temperature, dissolved oxygen, conductivity, turbidity, and fluorescence. These data help the researchers determine if these parameters that may affect clam behavior are within normal ranges.

In another component of the ECOPLEX project, UNT scientists are working with public school teachers in the area to develop curricula to about the complex relationships between watersheds, water quality, and water quantity, as well as other environmental issues.

Note: Waller can be contacted at (940) 565-2982 or waller@unt.edu. Some of Waller's earlier research to develop this clam-based water quality monitoring system was funded by the Texas Water Resources Institute (TWRI).

TPWD Creates Texas River Guide WWW Site

The Texas Parks and Wildlife Department has created a new World Wide Web (WWW) site with extensive information about Texas Rivers. The site, called "The Texas River Guide," contains both technical data as well as "user friendly" information for the public. The site includes a number of innovative features, including an interactive map that lets users identify individual points in a watershed and a discussion of safety and ethical issues.

The site also informs visitors about Texas stream navigation laws and significant river and stream segments. Other resources on this site include an online version of a handbook produced by TPWD, *An Analysis of Texas Waterways*, as well as flow data.

The address for this site is http://www.tpwd.state.tx.us/texaswater/rivers/index.htm